THE RELATIONSHIP BETWEEN TEAM CLIMATE AND PERFORMANCE IN SOFTWARE DEVELOPMENT TEAMS

THESIS

SUBMITTED FOR THE AWARD OF THE DEGREE OF

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BY

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DECLARATION

I do hereby declare that the thesis entitled "**The Relationship between Team Climate and Performance in Software Development Teams**" submitted to the Department of Business Administration, Faculty of Management Studies and Research, *Aligarh Muslim University*, Aligarh, India, for the award of the degree of *Ph.D (Business Administration)* is the original research work carried out by me under the guidance of Dr. Ayesha Farooq, Asst. Professor, Department of Business Administration, Faculty of Management studies and research, Aligarh Muslim University, Aligarh and Dr. Sanghamitra Patnaik, Associate Professor, Advanced Centre for American Studies, Osmania University Centre for International Programmes, Osmania University, Hyderabad. The thesis has not previously formed the basis for award of any Degree/Diploma/Associateship/Fellowship or other similar title to any candidate of any university/institution.

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This is to certify that the thesis titled **"The Relationship Between Team Climate and Performance in Software Development Teams"** submitted to the Department of Business Administration, Faculty of Management Studies & Research, Aligarh Muslim University, Aligarh for the degree of **Ph.D. (Business Administration)** is an original work done by **Mr. Goparaju Purna Sudhakar** during the period of his study under my supervision and guidance.

To the best of my knowledge and belief, the research work is based on the investigations made, data collected and analysed by him and it has not been submitted in any other University or Institution for the award of any degree or diploma.

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CERTIFICATE

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DEDICATION

To my father G.K.V.A.Sarma and my mother G.B.Devi,

To my wife Manjula and my daughters Manasa and Shruti

for their unconditional support, love and affection.

------ Goparaju Purna Sudhakar

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Performance Management, co-authored with Dr. Ayesha Farooq based on this PhD work.

Last but not the least I thank my family consisting of my father G.K.V.A.Sarma, retired teacher, mother G.B.Devi, my wife Manjula and my daughters Manasa and Shruti who have given me considerable time to do this research work. By the time I write my thesis my daughter Shruti is just six months old and making me busy all the time.

-- Goparaju Purna Sudhakar

PREFACE

Team orientation in industry has gained importance and visibility in 20^{th} century in Fortune 500 organizations. Organizations were getting the complex work done by teams. Researchers like Katzenbach and Smith, Cohen and Bailey, Gondal and Khan, Anderson and West, etc have done significant work on teams. Current day organizations are looking at the benefits they can get from teams. Team specific awards, rewards and recognition became a practice in many multinational organizations across the world. Hence, there is lot of significance and need for the study/research on teams.

"**The relationship between team climate and performance in Software development teams**" is a research work to find out the relationship between team climate, team productivity, team performance and team innovation in software development teams. Software industry is choosen because entire software product development can not be done alone by any individual. It should be done only by the teams because of the nature of complexity of work involved.

This thesis consists of six chapters, list of figures, list of tables, list of abbreviations and two Appendixes.

Chapter 1 is an introductory chapter explaining the Indian software industry, teams, few definitions of teams, the objective of this research study, purpose of this study, need for this research work, research framework and organization of this research study. It also explains from which journals major articles/papers were collected and during what duration literature review was done, etc.

Next, Chapter 2 is an exhaustive description of Indian software industry. The origins of Indian software industry, the early players, industry situation till 1990, the growth in 1990 till 2000, the journey from 2000 to present, the top industry players, opportunities for the industry, challenges before the industry, and manpower requirements and growth in the Indian software industry are explained in an exhaustive way. Lot of statistical data is provided to show the real growth of the Indian software industry. Its entire journey since inception till date is explained. It is basically about the industry for which this research study is useful.

Chapter 3 is focused on literature review. The past empirical studies, concepts, earlier work done on topics such as team climate, team performance, team productivity and team innovation are explained. The meaning of team climate, the constructs of team climate as explained by Anderson and West (1998), earlier work done on software development team's productivity (example works of Capers Jones, John Reel, Barry Boehm), how to measure team performance, earlier works on software development team's innovation are explained in this chapter. The models of team performance, models of team productivity, research gaps found in the literature useful for my study, the empirical studies done in India on software development teams using Team Climate Inventory (TCI) are explained in this chapter.

Next Chapter, Chapter 4 deals with the research methodology. The research objectives, research design, defining hypotheses, hypothesized research model, hypothesized structural model, sub-hypotheses, sample design, questionnaire design, development and administration, pilot study, final questionnaire development, how to go about data collection, respondents demographic details are explained in this chapter. The research model comprising the independent variable team climate and dependent variables team productivity, team performance and team innovation is explained pictorially along with hypotheses in this chapter.

Chapter 5 provides the analysis of collected data and results/findings discussion. Examination of collected data, correction of data, different statistical techniques used for the analysis such as mean, median, mode, correlation, regression, ANOVA, t-stat etc., hypothesis testing, multivariate analysis and testing relationships between team climate, team productivity, team performance and team innovation. This chapter consists of summary tables for null hypotheses supported or not supported. This chapter also consists of the Karl Pearson correlation coefficient values for the constructs of team climate and their relationship with team productivity, team performance and team innovation. It also has the regression coefficients values, t-stat and p-values to show the impact of team climate on team productivity, team performance and team innovation. The path analysis with structured equation modeling using LISREL 8.5 is explained in this chapter.

Answers to the key research questions, summary of research findings, contributions of this current research work, scope for further research, limitations of this research study and future research directions are explained in Chapter 6 titled "Research Findings, Conclusion and Directions for Further Research".

After chapter 6, a Bibliography is provided. Appendix – 1 consists of the detailed questionnaire used for this research study. Appendix-2 consists of the sample LISREL/SIMPLIS scripts written. Thorough out the thesis important topics have been high lighted and stressed. I hope this study will be useful for the industry.

---- Goparaju Purna Sudhakar

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AGFI	Adjusted Goodness of Fit Index
BSC	Balanced Score Card
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CMC	Computer Maintenance Corporation
CMM	Capability Maturity Model
COCOMO	Constructive Cost Model
COSL	Citicorp Overseas Software Limited
CSC	Common Service Center
DF	Degrees of Freedom
EFA	Exploratory Factor Analysis
EOU	Export Oriented Unit
ERP	Enterprise Resource Planning
FEMA	Foreign Exchange Regulatory Act
FP	Function Points
GDM	Global Delivery Model
GNDM	Global Network Delivery Model
GFI	Goodness of Fit Index
GoI	Government of India
HCL	Hindustan Computers Limited
IFI	Incremental Fit Index
IP	Intellectual Property
IS	Information Systems
ISD	Information Systems Development
IT	Information Technology
KD	Knowledge Diversity
KLOC	Kilo Lines of Code

LOC	**Lines of Code**
LSS	**Large Scale Software Projects**
MNC	**Multi National Company**
NASDAQ	**National Association of Securities Dealers Automated Quotation**
NNFI	**Non-Normed Fit Index**
NIIT	**National Institute of Information Technology**
ODC	**Offshore Development Center**
PGFI	**Parsimony Goodness of Fit Index**
RMSEA	**Root Mean Square Error of Approximation**
RMR	**Root Mean Square Residual**
SCEP	**Software Cost Estimation Program**
SDC	**State Data Center**
SEI	**Software Engineering Institute**
SEM	**Structured Equation Modeling**
SEZ	**Special Economic Zones**
SLOC	**Source Lines of Code**
SME	**Small and Medium Size Enterprise**
SWAN	**State Wide Area Network**
TCI	**Team Climate Inventory**
TCS	**Tata Consultancy Services**
TI	**Texas Instruments**
TNC	**Trans National Company**
TSI	**Team Selection Inventory**
VC	**Venture Capital**
VD	**Value Diversity**
US/USA	**United States of America**
UK	**United Kingdom**

Chapter 1 : INTRODUCTION

Chapter 1: INTRODUCTION

India is the fourth largest economy in the world according to purchasing power parity (NASSCOM, 2010). In current days, Indian IT industry has become the growth engine for Indian economy (NASSCOM, 2009). Indian software exports industry is one among the successful industries in the world (Dossani, 2005). *Teams* have got lot of importance in modern organizations. More than 70% of the Fortune 500 companies are using teams in their organizations. Many software MNCs are meeting their organizational objectives using software development teams. Teams are used to develop complex software products and applications.

According to Mathieu, Heffner, Goodwin, Salas and Cannon-Bowers (2000), increased technological advancements have lead to the more complex tasks, which can not be done by individuals so that the need for teams in organizations is growing to execute the organizational activities. *Teams* are better suitable to execute complex tasks (Mathieu, Heffner, Goodwin, Salas and Cannon-Bowers, 2000; Scott and Pollock, 2006). According to Cusumano, it is the management, which determines success and not the technology itself in software development projects (Blackburn, Lapré and Van Wassenhove, 2002). Hence, there is lot of importance for team management in software development projects.

1.1 Indian Software Industry: An Overview

N.R.Naraya Murthy (2000) of Infosys has termed Indian software industry as “faster, better and cheaper”. Indian Software companies are accepting the new methodologies, technologies and processes in reducing the response time, to improve the productivity and quality and to reduce the time to market.

According to Illiyan (2008), Indian software industry contribution to GDP has grown from 0.38% in 1991-92 to 5.5% in 2007-08. India exports software to more than 100 countries in the world and it has got the maximum number of SEI-CMM level 5 companies in the world (Illiyan, 2008). According to Arora, Arunachalam, Asundi and Fernandes (2000), Indian software industry is service oriented rather than product oriented, highly export oriented and managed by professional managers and entrepreneurs. The reason for much attention on Indian software industry is not because of its size, it is because of its growth rate (Chakraborty and Dutta, 2003). Major Indian software firms which are in software exports include TCS, Wipro, Infosys, and HCL. The MNCs having subsidiaries in India include Microsoft, IBM, ORACLE, HP, Accenture, SAP and DELL, etc.

Tschang (2001) said "Indian software industry can be considered as one of the 20th century's most surprising economic developments". It is because India has come from nowhere and became supplier of manpower to software products and services to US and rest of the world in 20th century. An example of this success story is Infosys, which was started by Narayana Murthy and colleagues, who scrapped together few hundred dollars to start the company, which was listed on NASDAQ with market capitalization of US $15 billion (Tschang, 2001).

According to Bajpai and Shastri (1998), Indian software industry has moved up the value chain by providing sersvices such as data entry, body shopping or manpower supply, offshore development, customized solutions, premium services, niche technologies and software products. Indian software firms range from large foreign multinationals to local multinationals to small startup companies. Indian software industry has started in Mumbai and migrated to Bangalore and then spread to other metro cities such as Delhi, Madras, Pune and Hyderabad. The early entrents into this industry are Tata Consultancy Services (TCS) (1968), Hindustan Computers Limited (HCL) (1976), and Computer Maintenance Corporation (CMC) (1978) (Tschang, 2001). Indian Railway Reservation system is an example large complex system developed by CMC. In 20 years, TCS has moved up the value chain and was able to move from body shopping to providing project management services to overseas customers.

1.2 Teams: An Introduction

Gondal and Khan (2008) have defined *Team* as a small group of people having common purpose, complementary skills and interdependent roles.

Another definition of *Team* is given by Katzenbach and Smith (2005a:163) as follows

"*A team is a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable*".

Cohen and Bailey (1997:241) have defined a *Team* as follows:
"*A team is a collection of individuals who are interdependent in their tasks, who share responsibility for outcomes, who see themselves and who seen by others as an intact social entity embedded in one or more large social systems (for example, business unit or corporation), and who manage their relationships across organizational boundaries*".

According to McDowell and Zhang (2009), teams are vital parts of organizations. Two thirds of the Fortune 500 organizations are using some form or the other of the teams in their organizations. There are more than 4,000 teams in Motorola working in their global offices (Sivasubramaniam, Murry, Avolio and Jung, 2002). Basically teams in modern organizations are of four types. They are work teams, parallel teams, project teams and management teams (Cohen and Bailey, 1997). Organizational structure has impact on team's functioning. Usually work teams are found in manufacturing and service industries. Parallel teams exist in literally parallel to the formal organization structure. Examples of parallel teams include quality circles, task forces, quality improvement teams, etc (Cohen and Bailey, 1997). Project teams are time bound. Once time expires, the team dissolves. Usually project teams are found in software and high technology industries. In current organizations management teams can be found at the top management or senior management level. Top management team's performance is nothing but the firm's performance (Cohen and Bailey, 1997).

According to Katzenbach and Smith (2005a) the characteristics of teams include specific team purpose, shared leadership roles, individual and mutual accountability, collective work products, encourages open-ended discussions, performance measurement by collective work products and discusses, decides and do real work together.

According to Cohen and Bailey (1997), team performance effectiveness measures include productivity, efficiency, response time, quality, customer satisfaction and innovation. Previous research on team performance effectiveness was done in three dimensions such as performance effectiveness in terms of quality and quantity of outputs, member attitudes and behavioral outcomes. Team member's participation has positive impact on team performance (Wagner, 1994). According to Sivasubramaniam, Murry, Avolio and Jung (2002), a team can influence it's team members as a leader can influence his followers. Highly effective teams have clear vision and focus (Katzenbach and Smith, 1993). Effectiveness is very much required for teams to achieve high levels of motivation and performance (Sivasubramaniam, Murry, Avolio and Jung, 2002). Building high performing software development teams, which uses state of the art technologies is going to meet the ever increasing demands of the stakeholders (Pattit and Wilemon, 2005). According to Pattit and Wilemon (2005), software project managers should assess their team performance to take corrective actions. Teams play important role in organizational learning (Edmondson, Dillon and Roloff, 2007).

There are many factors that affect the *productivity* and *performance* of software development teams. Team climate is one such factor which affects the performance of software development teams. According to Anderson and West (1996), team climate has constructs or dimensions such as *vision*, *task orientation*, *support for innovation* and *participative safety*.

1.3 Need for the Study

According to Loch, Stein and Terwiesch (1996), the profitability and sales of a business organization are dependent on the output and productivity of new product development function. In software organizations product development is done by software development teams. There is a close link between product development function and organizational success (Loch, Stein and Terwiesch, 1996). The higher the productivity levels of the software development teams means the lower the costs for the organization (Scacchi, 1995; Bouchaib and Charboneau, 2005). It is making the software development productivity an important topic in software industry (Bouchaib and Charboneau, 2005).

There is need for the study of this research topic of team climate, team productivity, team innovation and team performance because current day organizations are looking for better performance of the teams day by day. Hence, there is need for the study of this topic.

1.4 Objectives of the Study

The objective of the study is to identify and investigate the relationships among the factors/dimensions/constructs of team climate and team performance of software development teams.

The detailed research objectives are as follows.

1. To develop a hypothesized structural model consisting of team climate, team productivity, team performance and team innovation specific to software development teams.

2. To investigate the differences on the dimensions of team climate, team productivity, team performance and team innovation along four demographic variables such as *age, gender, educational qualifications* and *experience* in software development teams.

3. To investigate the differences on the dimensions of team climate, team productivity, team performance and team innovation along two organizational variables such as *team role* and *team size* in software development teams.

4. To investigate the relationship and impact of team climate on team productivity of software development teams.

5. To investigate the relationship and impact of team climate on team performance of software development teams.

6. To investigate the relationship and impact of team climate on team innovation of software development teams.

7. To investigate the relationship and impact of team productivity on team performance of software development teams.

8. To investigate the relationship and impact of team innovation on team productivity of software development teams.

9. To investigate the relationship and impact of team innovation on team performance of software development teams.

10. To develop a structural relationship among dimensions/constructs of team performance of software development teams

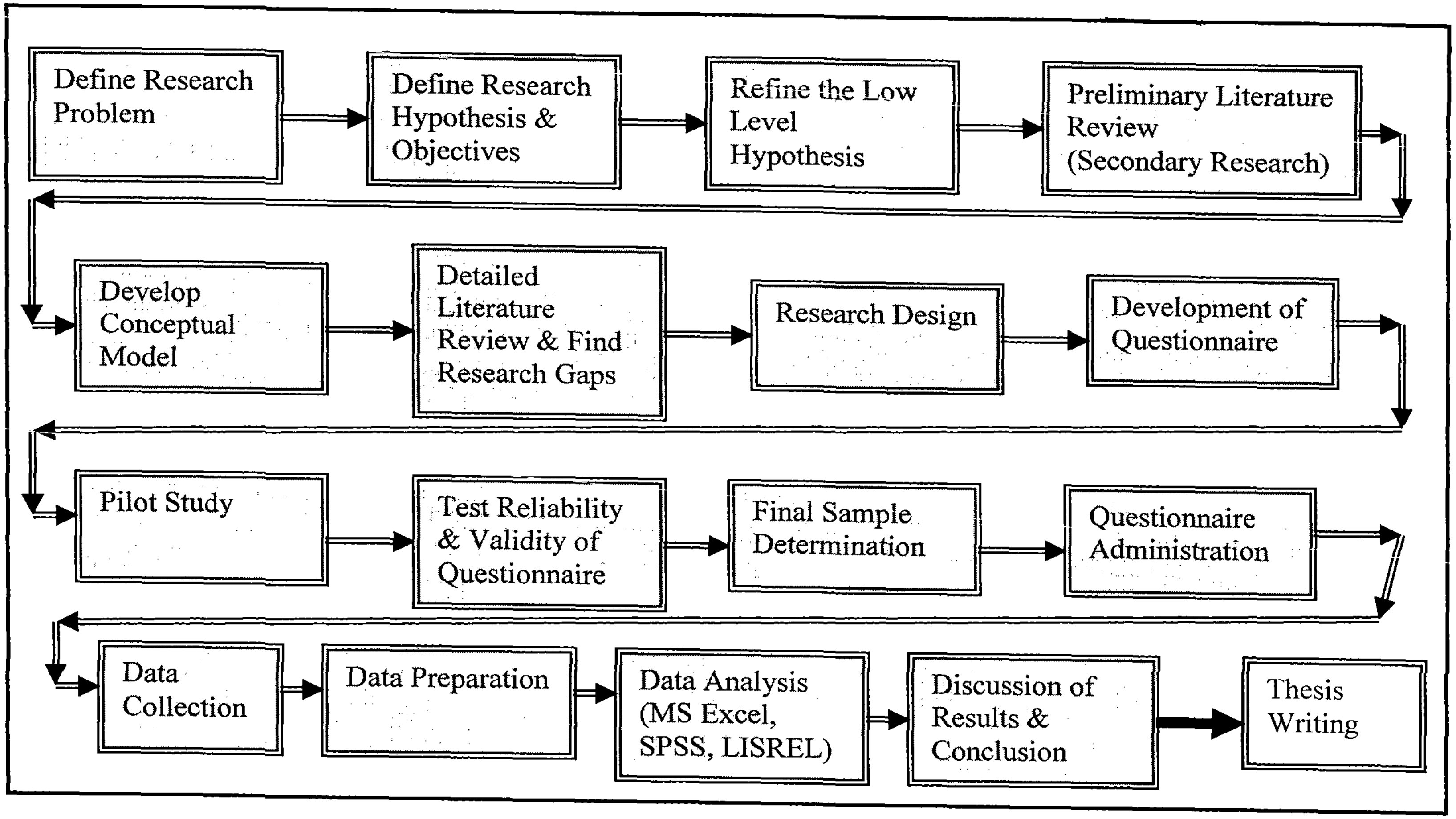
11. The objective is to make recommendations useful for Indian software industry related to team climate, team productivity, team performance and team innovation based on this research and give directions for future research.

This research also provides various factors/variables constitute team climate and can impact the team productivity, team performance and team innovation. A software organization can improve their productivity and performance based on the observation of the variables which have much impact on them. The software organization can work on those factors of team climate impacting the productivity, performance and innovation.

1.5 Research Framework

The framework of this research work is as shown in the Figure 1.1.

Figure 1.1: Research Framework



1.6 Organization of the Study

The current research has been organized as follows.

Chapter 1 consists of introduction to Indian software industry. It introduces the teams and definition of teams. Need for the research study is explained in this chapter. The objectives of this research and the research framework are also explained in this chapter.

The Indian software industry's origin and its growth till 1990, 1990 to 2000 and 2000 to till date are explained with needed figures, tables and graphs in *Chapter 2*. The opportunities for this industry, challenges for this industry and the future manpower requirements of Indian software industry are also explained in this chapter.

Chapter 3 consists of the detailed literature review. It is based on the research papers collected from secondary sources on the Internet such as Google, Google scholar, www.doaj.org (Directory of Open Access Journals), www.emeraldinsight.com, and www.openj-gate.com. Previous empirical studies on software team productivity, team performance and team innovation and team climate are cited. The models of team climate, team performance and team productivity are given along with the detailed identified research gaps. Articles from international and scholarly journals are cited. The exhaustive literature review was carried out between June 2009 and December 2010.

The detailed research methodology is explained in *Chapter 4*. Research objectives, high level and low level hypotheses are mentioned. Research design, sample size determination, questionnaire design, development and administration are also explained in this chapter.

Chapter 5 gives the data analysis and discussion of results. The data analysis is done using Microsoft Excel, SPSS statistical tool and LISREL 8.5 for Structured Equation

Modeling (Path Diagrams). The confirmatory factor analysis, results discussion and the relationship between different variables of the research model are explained in this chapter.

The current research is concluded and the directions for future research and limitations of the current study are explained in the *Chapter 6*.

Many Indian software organizations are competing with each other and want to make their teams more productive and get best customer satisfaction ratings for their organizations. Because of this many organizations are looking at the ways to reduce costs, increase profits and get the best out of the people they are having. In that direction they are looking at different ways to increase their software development teams' productivity and performance.

This chapter introduced the concept of team, definitions of team, an overview of software industry specifically Indian software industry, the specific need for this research study, research objectives, research framework under which the study has been carried out, and organization of the research study. The next chapter is an exhaustive explanation about Indian software industry and its growth path and growth history. It explains the growth path of Indian software industry from inception to till date, its opportunities and challenges ahead.

Chapter 2 : INDIAN SOFTWARE INDUSTRY

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The global IT spending has reached US $ 1.5 trillion in 2009 (NASSCOM, 2010). In 2010, Indian IT industry is estimated to reach US $ 73.1 billion. Out of this software and services account for US $ 63.7 billion. Domestic entrepreneurship was the key to the origin, survival, growth and innovation in Indian software industry (Dossani, 2005). Indian Software industry and its success has been discussed widely in number of studies (such as Krishnan and Prabhu (1999); Arora, Arunachalam, Asundi and Fernandes (2000); Murthy (2000); Tschang (2001); Chakraborty and Dutta (2003); Athreye (2005); Dossani, 2005; Arora (2006); Illiyan (2008); NASSCOM (2009); NASSCOM (2010); Athreye (2010)).

According to Athreye (2005), Indian software industry has seen phenomenal success to compare with other industries in India and India is enjoying competitive advantage in outsourcing and off-shoring of software projects. Due to the dynamic capabilities of Indian software industry, productivity has increased, which in turn resulted in increase in software exports (Athreye, 2005). Arora (2006) expressed that Indian software success is very helpful to Indian economy. The growth of Indian software exports can be seen from the following Table 2.1.

Table 2.1: Indian Software Exports Growth

Year	Exports (in Rs Crores)	% Growth
1985-86	34	-
1986-87	49	44.11
1987-88	70	42.85
1988-89	101	44.28
1989-90	175	73.26
1990-91	250	42.85
1991-92	410	39.62
1992-93	675	64.60
1993-94	1020	51.11
1994-95	1535	56.49
1995-96	2520	64.00
1996-97	3900	54.75
1997-98	6530	67.40
1998-99	10940	67.50
1999-00	17150	56.76
2000-01	28350	49.12
2001-02	36500	29.12
2002-03	46100	28.00
2003-04	58240	26.33
2004-05	80180	37.60
2005-06	104000	29.70
2006-07	141800	34.80
2007-08	163,000	15.6
2008-09	216,190	32.5
2009-10 *(estimated)*	235,080	8.7

(Source: Illiyan, 2008; GoI, 2010)

The types of software firms established in India were started by entrepreneur, multinational enterprises, US-Indian, Public Sector Enterprises, Business conglomerates and joint ventures (Athreye, 2005). According to Arora, Arunachalam, Asundi and Fernandes (2000), the software exports can be of three types.

They are

1. Executing onsite projects at client location by sending engineers from India.
2. Executing Partial work at onsite and rest at offshore in India and

3. Providing Offshore Development Centers (ODC) in India to the overseas customers.

According to Illiyan (2008), the factors that helped in the growth of Indian software industry include the timely delivery, quality of services, entry into new markets, Y2K business, international relations, the investor friendly steps taken by the Indian Government such as tax concessions, setup of STPIs, liberalized foreign investment policies, and large pool of English speaking engineers, low cost labor, difference of time zone between US and India, and the active role of NASSCOM. Top 20 Indian software companies, their revenues with growth percentage, year established are as shown in the Table 2.2.

Table 2.2: Top 20 Indian Software Companies

Rank	Company	2007-08 Revenue (Rs Cr)	2008-09 Revenue (Rs Cr)	Growth (%) 2008-09	Year Established	Type of the Firm
1	TCS	21,215	25,894	22	1968	Business House
2	Wipro	16,884	23,882	41	1980	Business House
3	Infosys Technologies	15,531	20,392	31	1981	Spin-off (patni)
4	Hewlett-Packard India	15,454	15,763	2	2002	MNC
5	IBM India	10,101	12,048	19	1987	MNC
6	Cognizant Technology Solutions	6,310	9,410	49	1994	Spawn (Dun & Broadstreet)
7	Ingram Micro	8,620	9,396	9	1989	-
8	HCL Technologies	6,200	8,764	41	1991	Entrepreneur
9	HCL Infosystems	5,058	8,089	60	1976	Entrepreneur
10	Redington India	6,280	6,576	5	1993	-
11	Cisco Systems	5,837	6,084	4	1995	MNC
12	Oracle India	5,808	5,962	3	1993	MNC
13	Intel India	4,310	4,698	9	1988	MNC
14	Accenture	3,800	4,400	16	1989	MNC
15	SAP India	3,260	4,320	33	1998	MNC
16	Dell India	3,232	4,266	32	1996	MNC
17	Tech Mahindra	3,637	4,195	15	1988	Business House
18	Microsoft India	3,263	3,298	1	2003	MNC
19	MphasiS	1,881	3,173	69	1992	Spin-off (Citibank)
20	Patni Computer Systems	2,569	3,011	17	1978	Entrepreneur

(Source: Dataquest, 2009; Arora, 2006; Researcher Complied)

2.1 Industry till 1990

Indian Software industry began in 1974. It began by supplying programmers and developers to global IT firms by Bombay based Tata Consultancy Services. Arora (2006) expresses that Indian software industry was started by renting out programmers to American clients by TCS. During 70s and 80s, domestic markets were absent and the government was hostile towards the private industry. Because of the hostile environment, despite having access to excellent programmers and developers, the industry was not able to gain expertise in areas such as project management and domain knowledge and was not able to grow in value addition (Dossani, 2005).

After a decade, because of the reforms in importing hardware and software, operating systems, main frames, programming language compilers were available in India, which in turn helped in Indian software industry moving from supplying programmers to supplying software programs to the global IT firms (Dossani, 2005). In 1980, Personal Computer (PC) was invented and since then the availability of workstations, to program and to connect to Mainframes and the vast usage of Unix and C has revolutionized the Indian software industry.

From 1970 to 1980, Indian software industry was supplying programmers to the global IT firms and in 1980-90 decade, they were developing custom software applications. Reduced import tariffs are the main reason for this development. In 1970s, Transnational Corporations have used Indian programmers for software maintenance work and later used them for research and development. In 1980s, domestic software start ups have started in India with the help of government research contracts catering to defence industry and later developing security software products to the global customers (Dossani, 2005). In 1970s and 1980s there were abundant number of engineers in India which could not be utilized for domestic industry purposes were emigrated to US. These people became entrepreneurs and they were driving the on-site part of Indian software exports by staying in US (Arora, 2006). TCS was the first firm to agree to export software after Government's approval for hardware import in 1974.

During 1970s and 1980s the state was regulatory and protectionist and it's strategy is to create the nation owned champion organizations. With the reforms like FEMA (Foreign Exchange Regulatory Act) of 1973 to achieve self reliance, companies such as IBM closed their India operations (Athreye, 2005). This has given opportunity to domestic firms in learning and porting applications from IBM platforms to other Unix based open systems. Software exports were exempted from income tax in 1985. Because of the low cost infrastructure, availability of power supply, communications infrastructure (Athreye, 2005), availability of scientific and engineering community and low real estate prices, Bangalore became the destination for software firms in India. Already there were nine Defence laboratories in Bangalore.

Mainly software companies were of two types during this time. They are hardware companies such as Wipro and HCL and software companies such as BFL, Satyam, Infosys, PCS, and Silverline (Arora, Arunachalam, Asundi, Fernandes, 2000). According to Tschang (2001), three types of software companies emerged in India. They are local offshore development centers (ODC), MNC own development centers and small startup companies.

In 1980, the top 8 software exporters from India include TCS, Tata Infotech, Computronics, Shaw Wallace, Hinditron, Indocos Systems, ORG and Systime. There were 21 companies in India with annual export revenues of $4 million (Dossani, 2005). Total number of software firms in India has increased from 35 in 1984 to 700 in 1990. In 1980s, the advantage Indian software industry was having is the cost advantage of cheap engineering talent (Athreye, 2005). Because of availability of cheap skilled programmers companies such as Texas Instruments (TI) and Citicorp Overseas Software Limited (COSL), investment of Citibank, have set up offices in India to develop software applications. Domestic software companies such as Infosys, Wipro, Sonata and Mastek have developed products however they were not having the needed domain knowledge or the marketing networks and were not able to penetrate into foreign markets (Athreye, 2005). The successful "onsite" model started by TCS was reproduced by many firms which entered the industry in early 1980s (Arora, 2006).

2.2 Industry (1990-2000)

According to Chakraborty and Dutta (2003), the number of software firms has grown substantially in India after 1990-91. During 1990-2000 decade, Indian software industry moved up the value chain and providing managed services, product R & D and product development. The friendly policies of Indian government helped in this direction are the reforms in venture capital (VC), IP, Telecom, stock market rules, and allowed foreign ownership (Dossani, 2005). In 1990, the top 8 software exporters include TCS, Tata Infotech, Citibank, Datamatics, Texas Instruments, DELL, PCS, and Mahindra-British Telecom.

In 1998, Indian IT industry is contributing 1.2% to the national GDP (GoI, Undate). During this decade Indian IT and BPO industries have gained lot of reputation for their information security and for maintaining standards in service quality. In 1990s, the development of database management systems and reduced cost of PC has reduced the application development times as well (Dossani, 2005). In mid 1990s the profile of Indian software industry and its competitors in software services, data entry and software packages composition wise is as shown in the Table 2.3.

Table 2.3: Indian software Industry Profile and its Competitors in Mid 1990s.

Country	**Software Services (Excluding Data Entry) - %**	**Software Packages (%)**	**Data Entry (%)**
India	90	5	5
Ireland	65	21	14
Mexico	53	32	15
Philippines	39	20	41
Singapore	25	58	17
China	17	56	27
Israel	19	76	5

(Source: Chakraborty and Dutta, 2003)

In 1991, Indian government has established STPI (Software Technology Parks of India) to promote and boost software exports from India. Indian government is trying to attract more foreign investments in this industry by bringing transparency in procedures and policies and to provide investor friendly environment for the foreign investors. Special schemes to increase the software exports, provided by Indian government include STP scheme, Export Oriented Unit (EOU) Scheme, and Special Economic Zones (SEZ) schemes. The Telecom reforms in 1999 and growth of Internet helped the Indian domestic software firms to cater to the needs of global IT companies (Dossani, 2005). Indian software industry has seen an annual compound growth rate of 40.5% between 1994 and 1999 (Tschang, 2001).

According to Dossani (2005), due to lack of venture capital and lack of domain skills, the product development by Indian software companies has taken back seat. This is evident from the contribution of product development in total software exports was only 9% in 1999. The growing competition between different Indian software houses in 1990s made them to invest in process management and organizational capabilities (Athreye, 2005).

In this decade, the onsite-offshore model practiced by Tata Consultancy Services and Infosys became popular in the Indian software industry. Infosys has also developed the Global Delivery Model (GDM) and TCS has developed Global Network Delivery Model (GNDM) to cater to the needs of global customers and have shown that this model is profitable for the performing organization. By 1998, more than half of SEI-CMM level 4 or 5 certified software organizations in the world were in India. Wipro has concentrated on Telecom domain and R & D, TCS and Infosys have concentrated on Financial and insurance domains and Satyam has concentrated on automation systems for transport manufacturing (Athreye, 2005). In 1997, the median number of employees in a NASSCOM member firm was 70 and the maximum number of employees in a firm was 9000 (Arora, 2006). During 1996-97 the NASSCOM membership was 430 and in 1997-98 it went up to 620 (Arora, Arunachalam, Asundi and Fernandes, 2000). In 1997-98, 58% of the software exports were to US, 21% to Europe and 4% for Japan. In 1997, there were around 160,000 people working in Indian software industry which is 20,000 more from previous year (Arora, Arunachalam, Asundi and Fernandes, 2000). In 1999-2000, Indian software industry size was US$5.7 billion, where as ten years ago, it was just US$150 million (Chakraborty and Dutta, 2003).

Table 2.4: India's Growth Path during 1990-2000

Year	Total Revenues ($M)	Manpower	Revenue per Employee ($)
1993-94	557.9	90,000	6,198.5
1994-95	825.8	118,000	6,998
1995-96	1249.4	140,000	8,924.5
1996-97	1765.8	160,000	11,036
1997-98	2700	180,000	15,000
1998-99	3900	200,000	19,500
2000-01 *(Est.)*	6000	250,000	24,000

(Source: Chakraborty and Dutta, 2003)

In this decade, mainly software exports include software services such as software application maintenance for IBM mainframe systems, development of small applications, enhancements of existing applications, re-engineering, and migration to client server systems (Arora, Arunachalam, Asundi and Fernandes, 2000). According to Chakraborty and Dutta (2003), 2/5th of the Fortune 500 companies have outsourced their work to India by 2000.

2.3 Industry (2001-Present)

In 2009, Indian Software industry was hit by the global recession. However, with the help of stimulus packages released by different governments in the world helped in showing the recovery of the industry by the end of the year (NASSCOM, 2010). Because of this recession, global customers of the Indian software industry cut the IT spending, cut the billing rates, negotiated the billing prices, reduced the headcounts, and delayed payments to the performing organizations. However in 2010, there are deal flows, stable pricing, growth in volume and faster decision making from the customers in the industry (NASSCOM, 2010). The major developments after 2000 in Indian Software industry are the growing size of outsourcing deals and growing offshore component revenues (Athreye, 2005). According Arora (2006), over a period of time more important and more complicated work was moved to India from overseas customers.

Indian IT industry's contribution to GDP is estimated to be 6.1% in 2010. Its contribution in exports has increased from 4% in 1998 to 26% in 2010. Indian domestic IT industry is expected to grow at 12% in 2010 (NASSCOM, 2010). Where as the domestic market in US generates $3/4^{ths}$ of its IT revenues (Chakraborty and Dutta, 2003). According to NASSCOM (2010), Indian software industry has been transforming by increasing R&D spending, increasing interest in IP (Intellectual Property) creation, developing new tools and technologies, increased domain expertise, and innovations in business models. Indian software services exports have increased from US $330 million in 1993 to US $17.3 billion in 2006 with manpower around 878,000 (Athreye, 2010). According to Athreye (2010), Indian firms such as TCS and Infosys have gained reputation for quality and getting more work from customers.

During 2004 to 2008, global sourcing has increased threefold (NASSCOM, 2009). There is 29 times increase in number of patents from Indian IT industry from 2005 to 2008. The average R&D spending of Indian IT industry is around 1% of revenues (NASSCOM, 2010). NASSCOM's vision is Indian IT industry will reach US $225 billion by 2020. The growth of Indian software industry is evident from the Table 2.5.

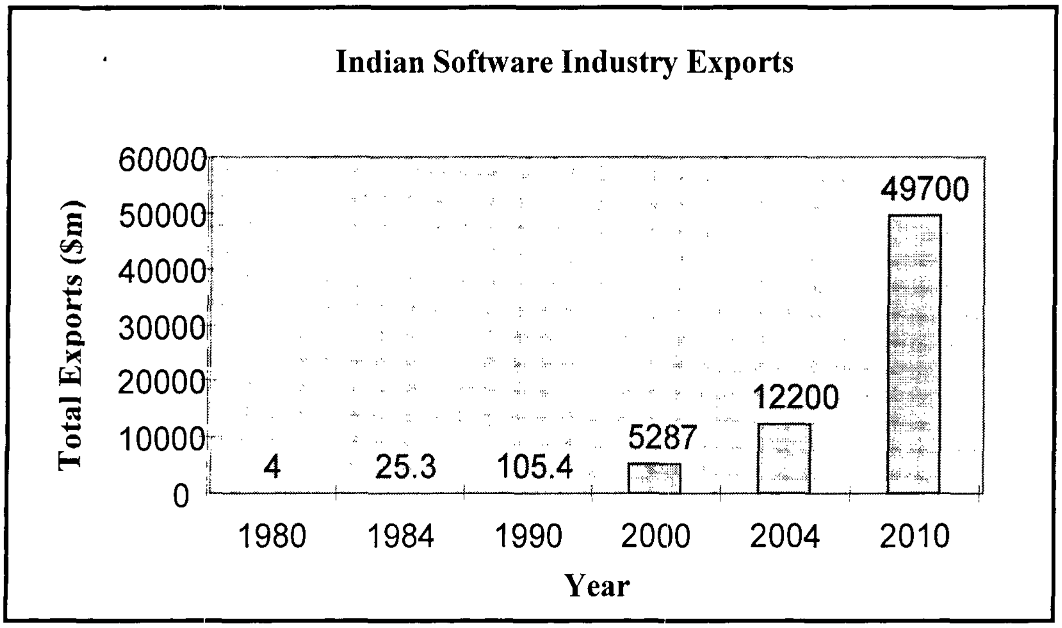
Table 2.5: Indian Software Industry Growth

Year	Total Exports ($m)	No. of Firms	Average revenue per firm ($)	Average revenue per employee ($)	Exports/Total Revenue (%)
1980	4.0	21	190,476	16,000	50
1984	25.3	35	722,857	18,741	50
1990	105.4	700	150,571	16,215	N/A
2000	5287	816	7,598,039	32,635	71.8
2004	12200	3170	7,003,154	35,362	73.9
2010 (Estimated)	49700	N/A	N/A	N/A	N/A

(Source: Dossani, 2005; The Economic Times dated 04-Feb-2010).

In 2004, the top 8 software export companies include TCS, Infosys, Wipro, Satyam, HCL, PCS, i-flex and Mahindra-British Telecom (Dossani, 2005). In this 2000-2010 decade, Indian software houses have move up the value chain from application development, maintenance to providing system integration, consulting, testing services and infrastructure services (NASSCOM, 2009). Many of the Indian software companies are providing remote infrastructure maintenance services in current days. The growth of Indian software industry can be seen in the Figure 2.1.

Figure 2.1: Indian Software Industry Exports ($m)



(Source: Dossani, 2005; The Economic Times dated 04-Feb-2010)

In this decade, Government of India has taken initiatives such as establishing national e-Governance plan, setting up state wide area networks (SWAN), State Data Centers (SDC), Common Service Centers (CSC), and setting up of National Knowledge Network. To increase the profitability, Indian software firms were trying to increase the productivity by making use of different tools, efficient practices and by making use of unqualified staff and train them with organization specific technologies and tools (Athreye, 2005).

Arora (2006) observes that Indian software production and exports have grown rapidly since 1990. The number patents filed by and granted to Indian software firms during 2004-06 is as shown in the following Table 2.6.

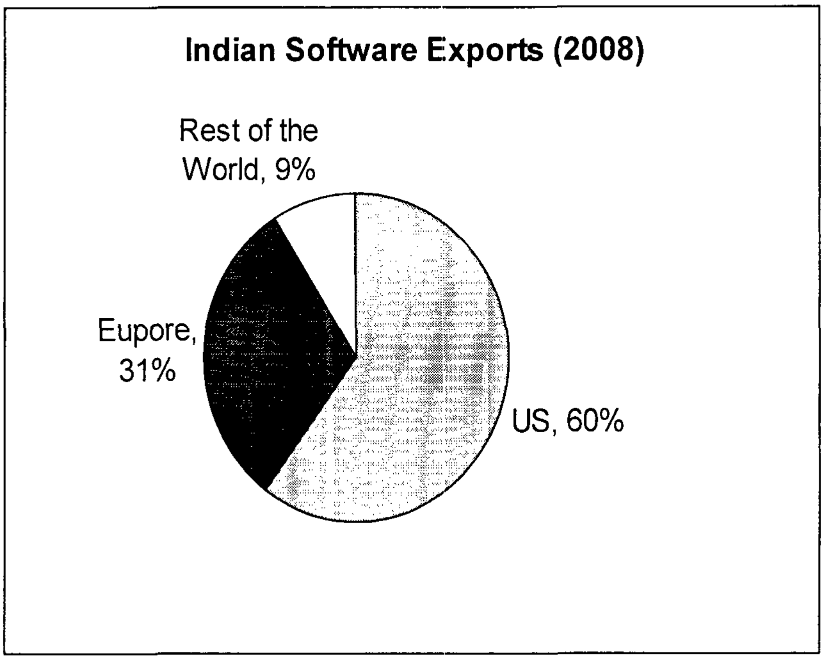
Table 2.6: Patent Information of Indian Software Firms

Indian Software Company	2004-05		2005-06	
	Patents Filed	Patents Granted	Patents Filed	Patents Granted
Infosys	-	-	20	-
Ramco	16	-	16	-
TCS	16	5	13	4
Sasken	5	-	5	5
Mindtree	1	-	2	-
Subex	-	-	2	-
i-flex	1	-	1	-

(Source: Arora, 2006)

The companies that have invested in research and development to achieve product innovation in India are Motorola, Cisco Systems, Hewlett-Packard, General Motors and Google. The Indian software exports in FY 2008 constitute 60% to US, 31% to Europe (including UK) and 9% to the rest of the world. They are as shown in the Figure 2.2.

Figure 2.2: Indian Software Exports to Different Geographies



(Source: NASSCOM, 2009a)

Overall the annual average growth rate of Indian software exports for the past 3 decades can be seen from the following Table 2.7:

Table 2.7: Annual Average Growth Rate of Indian Software Exports

Period	Annual Average Growth Rate (%)
1985 to1991	49.40
1991 to 2001	57.13
2001 to 2008	28.42

(Source: Illiyan, 2008)

2.4 Opportunities for Indian Software industry

Indian software industry can enter into new markets, verticals, segments and geographies with the help of the stakeholders such as industry, NASSCOM and the government (NASSCOM, 2010). With the help of these stakeholders, India can be represented as a trusted global and innovation hub for professional services by encouraging intellectual property and entrepreneurship. Indian software companies are encouraging the culture of innovation, which supports solutions based on reengineering and transformation (NASSCOM, 2009).

The current opportunities for the industry include growing outsourcing in areas such as customer support, financial services, manufacturing, IT and IT Enabled Services (ITES). According to Murthy(2000), the people in US has rated India as No.1 in software outsourcing and 25% of the Fortune 1000 companies have outsourced their work to India. The competitive advantage India is having is the availability of English speaking professionals (Chakraborty and Dutta, 2003) and it is the second largest talent pool after US (Murthy, 2000). Even though Israel and Ireland were close to Indian software industry performance, India's growth rate is too high and it is going to sustain it because of the available engineering talent (Tschang, 2001). According to Illiyan (2008), China is having around 1000 software companies in and around Bejing; however, none of those companies is rated at CMM level 4 or 5. Now Chinese software companies are trying for quality certifications. The status of quality certifications of the Indian software companies can be observed from the following Table 2.8.

Table 2.8: Quality Certifications of Indian Software Companies

Certification	No. of Companies
ISO 9001	330
ISO 9002	23
ISO 9001/9002	345
ISO 9001:2000	72
SEI CMM Level 5	82
SEI CMM Level 2, 3, 4	41
SEI CMMi Level 5	32
SEI CMMi Level 2, 3, 4	14
PCMM Level 5	13
PCMM Level 2, 3, 4	11
Six Sigma	44

(Source: Illiyan, 2008)

The quality, methodologies and technologies are the strengths the Indian software companies are traditionally having. According to Tschang (2001), Indian software industry success is because of hard work and the demand for personnel in the US information technology industry. According to him it is difficult for any other country to replicate the success of Indian software industry because there are hard factors such as education and infrastructure and soft factors such as culture and social networks.

According to Arora, Arunachalam, Asundi and Fernandes(2000), because of the weaknesses in the Indian financial system, many entrepreneurs were benefited in starting new companies with very little investment. According to US managers, Indian vendors are willing to learn, flexible, receptive to new ideas in providing software solutions to the customers (Arora, Arunachalam, Asundi and Fernandes, 2000). According to Krishnan and Prabhu (1999), India has got ample scope for product development and product development would allow creativity of Indian programmers to reach to the high levels which is already known internationally. According to them software services are highly profitable and low risky business for India.

According to Chakraborty and Dutta (2003), the industry friendly policies of Indian government in improving the infrastructure and the generation of abundant skilled manpower have became competitive advantages for India and they built the confidence in overseas customers. The advantage for Indian software industry is majority of software developers in India are US trained and they understand the market better than any other competing country (Chakraborty and Dutta, 2003). According to Chakraborty and Dutta (2003), in order to sustain the growing competition in the world, Indian software companies have to develop new products which are at the high end of the value chain.

According to Tschang (2001), to sustain the growth rate, Indian software industry has to innovate and create more intellectual property by creating more startup companies.

2.5 Challenges for Indian Software industry

According to NASSCOM (2010), the challenges Indian software industry faces are the increasing costs because of wage inflation and increased attrition and the fresh graduates produced in India are largely trainable but not employable readily. The challenges Indian software companies faces are poor project management skills (Arora, Arunachalam, Asundi and Fernandes, 2000; Tschang, 2001) and lack of domain knowledge (Arora, Arunachalam, Asundi and Fernandes, 2000).

According to Arora (2006), raising wages and increasing employee attrition are main challenges Indian software industry is facing. Indian software firms continue to be mostly services oriented and little scope for production development. Indian software firms may face stiff competition from companies in China, Eastern Europe or Philippines. Many observers of Indian software industry said that the Indian cost advantage will go away unless it starts spending on research and development (Arora, 2006). Indian software companies have seen limited success as far as product development is concerned and also technological innovation should come from startups and new entrants into the industry. The product revenues of the top Indian software companies are listed in the following Table 2.9.

Table 2.9: Product Revenues of Indian Software Companies

Indian Software Company	Revenues in Rs Crores		% Growth
	FY 2009	FY 2008	
i-flex	1,805	1,432	26
3i Infotech	840	596	41
Infosys	848	598	42
TCS	828	679	22
Subex	502	362	39
Teledata	499	993	-50
Cranes	485	390	24
Geodesic	392	222	77
Polaris	259	219	18
Nucleus	226	197	15
Total	6,684	5,688	18

(Source: Shashwat, 2009)

The companies in Eastern Europe, Latin America and South Africa are competing with Indian software firms in providing low cost outsourcing services to the global customers. Countries like Israel and Singapore are high in quality and also high in cost and countries like Philippines, China and Hungary are low in quality and low in cost. Another challenge Indian software industry is facing is metro cities are getting saturated and the industry needs to find suitable tier-II cities to cater to the growing needs of the industry. Bringing the best and qualified people into the industry to achieve sustainability and value addition is the greatest challenge Indian software companies are having (Murthy, 2000). According to Murthy (2000), adaptability, flexibility, agility and retaining customer are other challenges Indian software companies are facing. According to Tschang (2001), in the initial days of the industry, India has to overcome the issues such as infrastructure, roads and poor telecommunications. Later on STPIs provided reliable power supply and data communication facilities to the export oriented software houses.

According to Arora, Arunachalam, Asundi and Fernandes(2000), the main challenge to Indian software industry is the non availability of skilled manpower (Illiyan, 2008), diminishing labor cost advantage and possible competition from low wage and human capital rich countries in the region. Arora, Arunachalam, Asundi and Fernandes (2000) have expressed that obtaining finance for product development is another challenge, Indian software companies are facing today. Good data communication infrastructure is very much needed to the continued growth of the industry. The other challenges for Indian software industry include lack of understanding of the US work culture, resistance within US for foreign programmers, delays in visa processing, and poor telecommunications infrastructure in India (Arora, Arunachalam, Asundi and Fernandes, 2000).

According to Arora, Arunachalam, Asundi and Fernandes (2000), the two main challenges for Indian software industry include attracting and retaining the talent and maintaining the cost advantage against raising labor costs in India. According to Krishnan and Prabhu (1999), there are social and organizational constraints for software product development in India. Those issues are related to Intellectual property related and knowledge management related. The challenge one sees in product development is developing product without functional or domain knowledge (Krishnan and Prabhu, 1999). For example, Indian software companies such as Mastek has developed an ERP product known as MAMIS, Ramco Systems has developed a product an ERP product known as Marshall. In the early days of the industry, Indian software firms have exported the products such as compilers and financial packages to overseas markets, however, these earnings were insignificant (Chakraborty and Dutta, 2003).

According to Suma Athreye (2010), India is ranked at 116 (out of 155 countries) in a ranking related to how difficult is to do business in India. Hence, this is another challenge in attracting foreign investors into the country. According to Chakraborty and Dutta (2003), Indian software companies are rated low by abroad clients in factors such as managing projects, quality control and access to new technologies. The low investments in R & D have lead to the missed opportunities in the indigenous technology developments and new product developments (Chakraborty and Dutta, 2003). Hence, Indian developers should continuously concentrate on product and process innovation. Lack of major share of domestic market was the significant problem in Indian software industry (Chakraborty and Dutta, 2003, Illiyan, 2008). According to the research done by Chakraborty and Dutta (2003), the foreign participation in joint ventures and wholly owned subsidiaries is minimal till today.

According to Illiyan (2008), the challenges ahead for Indian software industry are the sustainability of growth rate in future, shortage of skilled manpower, weak domestic market, low growth of domestic hardware industry, rupee appreciation and US economic slowdown and concentration on services rather than on products.

2.6 Needed Manpower for the Indian Software Industry

Indian IT industry is employing 2.3 million people directly and 8.2 million people indirectly and it is going to recruit another 90,000 in 2010 (NASSCOM, 2010). According to NASSCOM (2009), every single IT job is creating 3.6 additional jobs in related sectors and industries. Industry has added 226,000 headcount in 2008 itself (GoI, Undate). According to NASSCOM (2009), India is producing over 3.5 million graduates and post graduates every year, which is a pool of talented human resources in the world.

In 1999, there were 247 universities and 11,549 colleges in India. Only 27.12% of people working in Indian software industry were having Computer Science or Electrical Engineering undergraduate degrees and the industry-academia interaction was minimal (Dossani, 2005). In 2001, India was producing only 25 PhDs and 300 post graduates in Computer Science. Where as, US was producing 800 and 10,000 respectively. According to Arora (2006), Salaries for software professionals in India are much lesser to compare with developed countries. Indian software companies are even spending 3-4% of their revenues on training their work force every year.

Table 2.10: Production of Engineering graduates by Engineering Colleges in India

Year	No. of Graduates Produced
1951	4,788
1985	45,136
1995	1,05,000
2004	4,39,689
2009	820,000

(Sources: Arora, 2006; Biswas, Chopra, Jha and Singh, 2010)

There were many measures to increase the manpower for Indian software industry by the public sector and industry. Such measures include establishment of Indian Institutes of Information Technology (IIIT) along the lines of IITs to produce qualified and well trained software engineers useful for the industry (Arora, Arunachalam, Asundi and Fernandes, 2000). According to Chakraborty and Dutta (2003), India has taken steps to triple the production of engineering graduates by 2008.

According to Tschang (2001), India has got traditionally strong Mathematics and logical capabilities and this became a competitive advantage for India with more Mathematics oriented and engineering graduates. The level of innovation of Indian engineers can be observed from the following Table 2.11 having the number of patent applications filed by different countries in 1997.

Table 2.11: R & D and Innovation Levels

Country	Total Number of Scientists and Engineers (Average over 1987-97)	Patent Applications Filed (1997)	
		Residents	Non-Residents
China	527,066	12,786	48,596
India	131,314	10,155	--
Ireland	8,263	946	82,484
Israel	-	1,796	28,548
Japan	609,740	351,487	66,487
Korea	95,848	92,798	37,184
Singapore	6,538	8,188	29,467
Thailand	5,874	238	5,205
United States	937,012	125,808	110,884

(Source: Tschang, 2001)

According to Tschang (2001), India needs more business and technological skills in order to become more innovative and have more control over the Intellectual property it creates. These business skills needed are entrepreneurial, conceptual skills and business development skills. The technical skills needed are product development skills, coding and programming skills, systems skills, project management skills, requirements analysis, systems analysis, and advanced innovative technical skills (Tschang, 2001). According to Tschang (2001), the skills that will be in demand are the development of software business applications, web based applications, application service providers, software engineering, product innovation, middle layer of product development and project management skills.

According to NASSCOM (2010), Indian government should encourage Indian software industry by simplified tax structures, which brings the foreign investments into the country. Over a period of time Indian Software Industry has acquired skills of managing projects remotely (Murthy, 2000; Dossani, 2005) using inexperienced programmers and managers (Arora, 2006). According to Chakraborty and Dutta (2003), both the foreign and domestic markets for both services and products are growing at rapid rate for Indian software firms.

In this chapter we have seen the history of Indian software industry since inception till date, and who are the top players, its opportunities and challenges ahead. Next chapter is an exhaustive literature review on topics such as team climate, team productivity, team performance and team innovation.

Chapter 3 : LITERATURE REVIEW

Chapter 3: LITERATURE REVIEW

According to Bahli and Büyükkurt (2005), modern organizations require teams to perform their organizational tasks. New product development teams, information systems teams, and advertising teams are some of the examples of teams in modern organizations (Bahli and Büyükkurt, 2005). The software development team performance is an important topic in information systems domain in current days (Liang, Liu, Lin, and Lin, 2007). According to K.S.White (1999), a project manager should keep well with team members and value their contributions to achieve better productivity and performance. According to Acuña, Gómez and Juristo (2008), people are main concern in software project success or failure.

Summary of empirical studies on team climate, team productivity, team performance and team innovation in Software Development Teams are as shown in Table 3.1.

Table 3.1: Software Development Teams' Empirical Studies

Sl. No.	Researcher(s)	Team Climate	Team Productivity	Team Performance	Team Innovation
1.	Ganesh and Gupta (2006)	X			
2.	Acuña, Gómez, and Juristo (2008)	X			
3.	Tausworthe (1982)		X		
4.	Banker, Datar and Kemerer (1991)		X		
5.	Tockey (1996)		X		
6.	Krishnan, Kriebel, Kekre and Mukhopadhyay (1999)		X		
7.	Potok and Vouk (1999)		X		
8.	Nogueira, Luqi, Berzins and Nada (2000)		X		
9	Andres (2002)		X		
10.	Blackburn, Lapre and Van Wassenhove (2002)		X		
11.	Card (2006)		X		
12.	Jiang and Comstock (2007)		X		
13.	Nwelih and Amadin (2008)		X		
14.	Sawyer and Guinan (1998)			X	
15.	Sawyer (2001)			X	
16.	Ong, Tan and Kankanhalli (2005)			X	
17.	Bahli and Büyükkurt (2005)			X	
18.	Ramasubbu and Balan (2007)		X	X	
19.	Liang, Liu, Lin, and Lin (2007)			X	
20.	Na, Simpson, Li, Singh and Kim (2007)			X	
21.	Huckman, Staats and Upton (2009)			X	
22.	MacCurtain, Flood, Ramamoorthy, West and Dawson (2008)				X
23.	Wei and Xie (2008)				X

(Source: Researcher Compiled)

3.1 Concept of Team Climate

The concept of *Climate* has got lot of significance for the past three decades from the organizational sociologists and applied psychologists (Anderson and West, 1998). According to Anderson and West (1998), the definition of *Climate* has two approaches such as *Cognitive schema approach* and *Shared perceptions approach.* According to James and Sells (1981), *Climate* can de defined as "individuals' cognitive representation of proximal environments, expressed in terms of psychological meaning and is significant to individuals".

According to Reichers and Schneider (1990), *Organizational Climate* is the shared perception of organizational policies, procedures and practices. According to Gautam, Upadhyay, Dick, and Wagner, learning about Organizational climate has started from 1930s from a confluence of field theory. As Gautam, Upadhyay, Dick, and Wagner said *Organizational culture* is something to do with values and belief system of individuals in the organization. Where as *Organizational Climate* is something to do with organizational policies, procedures and practices. *Team Climate* is the shared perceptions referring to the proximal work group (Anderson & West, 1998).

According to Anderson and West (1994), *Team Climate* can be defined as the manner of working together which includes aspects like vision, innovation, communication patterns, participation safety, norms, cohesion and task style. Yuan, Chaoying and Peng (2008) said "team climate differs from organizational climate, as it focuses on the proximate work environment for individuals who relate to each other more closely".

According to Yuan, Chaoying and Peng (2008), the most popular model for team climate has been developed by West (1990). West (1990) has developed the four factor theory of climate for work group innovation. The four factors include *vision, task orientation, support for innovation* and *participative safety* (West, 1990; Anderson and West, 1998). Anderson and West (1998) have studied 27 hospital management teams in UK to validate and measure the multi-dimensional facetspecific climate for innovation within work teams known as *Team Climate Inventory (TCI)*. TCI is a measure to find the team climate for innovation in work groups. TCI has been used in many studies (Liu and Cheng (1996); Anderson and West (1998); Curral, Forrester, Dawson and West (2001); Bain, Mann and Pirola-Merlo (2001); Mathisen, Einarsen, Jørstad and Brønnick (2004); Ganesh and Gupta (2006); Hann, Bower, Campbell, Marshall and Reeves (2007); Proudfoot, Jayasinghe, Holton, Grimm, Burner, Amoroso, Beilby, Harris and PRACCAP Research Team (2007); Kivimäki, Vanhala, Pentti, Länsisalmi, Virtanen, Elovainio, and Vahtera (2007); Gautam, Upadhyay, Dick and Wagner (Undated); Bosch, Dijkstra, Wensing, Weijden and Grol (2008); Yuan, Chaoying, Peng (2008); Acuña, Gómez and Juristo (2008); Strating and Nieboer (2009)).

TCI has been used in health care teams, social service teams, software teams, community psychiatric care teams, oil company teams (Bain, Mann and Pirola-Merlo, 2001) and management teams (Mathisen, Einarsen, Jørstad and Brønnick, 2004). Hence, According to Anderson and West (1998) and West (1990), team climate for innovation consists of the four constructs such as *vision*, *task orientation*, *support for innovation* and *participative safety*.

According to West (1990), *Vision* is "an idea of a valued outcome which represents a higher order goal and a motivating force at work". It constitutes components such as clarity, visionary nature, sharedness and attainability.

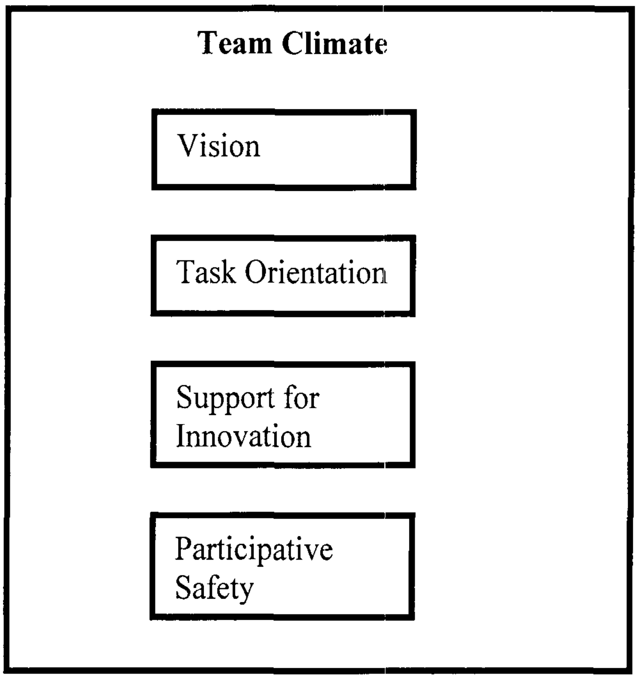
According to West (1990), *task orientation* is defined as "a shared concern with excellence of quality of task performance in relation to shared vision or outcomes, characterized by evaluations, modifications, control systems and critical appraisals".

Support for innovation is the "exception, approval and practical support of attempting to introduce new and improved ways of doing things in work environment" (west, 1990).

Participative safety is characterized as single psychological construct in which involvement in decision-making is encouraged and motivated in a non-threatening environment (West, 1990).

The four factor model of *Team Climate* for Innovation is as shown in Figure 3.1 as developed by West (1990).

Figure 3.1: Four Factor Model of Team Climate for Innovation



(Source: West, 1990)

Mathisen, Einarsen, Jørstad and Brønnick (2004) have studied 395 Norwegian postal distribution teams to find the relationship between team climate and customer satisfaction and they found the positive relationship between these two. They found that the positive team climate leads to the satisfied customers and satisfied customers lead even better team climate.

Bain, Mann and Pirola-Merlo (2001) have studied 18 research and 13 development teams in Australian R & D organizations to find out the relationship between team climate and team performance and innovation in research and development teams. According to them team climate for innovation is very important for R & D teams because R & D involves producing innovations. Team climate for innovation is supportive of team performance (Bain, Mann and Pirola-Merlo, 2001). Their study found that team climate has strong relationship with team innovation and team performance in research projects than the development projects.

Hann, Bower, Campbell, Marshall and Reeves (2007) have surveyed 492 professionals working in 42 general practice teams in UK health care industry to find the relationship between culture, climate and quality of primary health care teams. They found that there is no significant relationship between culture and quality of service in health care teams. However, there is evidence of association between climate and quality in primary health care teams.

Proudfoot, Jayasinghe, Holton, Grimm, Burner, Amoroso, Beilby, Harris and PRACCAP Research Team (2007) have studied 654 general practitioners and staff, 7505 chronically ill patients in 93 general practices in Australian hospitals to find the relationship between team climate and patient's satisfaction and job satisfaction of the staff. They found that the better team climate resulted in greater patients' satisfaction and job satisfaction of the staff and general practitioners.

Kivimäki, Vanhala, Pentti, Länsisalmi, Virtanen, Elovainio, and Vahtera (2007) have done a longitudinal study of 6,441 hospital employees in Finland to find out the relationship between team climate and intention to leave the job and actual turnover among hospital employees. They found that the likely hood of leaving the job is high for those employees who have self-rated the poor team climate.

Curral, Forrester, Dawson and West (2001) have surveyed 87 cross industry Portuguese teams (advertising, pharmaceutical, health, banking, manufacturing, IT and research teams) to find the relationship between task type, team size and innovation related team processes. They found that teams reported high levels of participative safety and support for innovation reported high scores on a measure of team processes.

Gautam, Upadhyay, Dick, and Wagner have surveyed 450 employees of five Nepalese organizations in Bank, Telecom and Television industries to find the relationship between team climate and organizational commitment in Nepal. They found that team climate predicts the affective and normative commitment in Nepal. They have used 14 item short version of TCI developed by Kivimaki and Elavionio.

Yuan, Chaoying, and Peng (2008) have surveyed 208 team members in 31 R & D teams in China to study the relationship between team climate and perceived innovativeness in the team. They found positive relationship between team climate and perceived innovativeness. They also found significant and strong relationships between *support for innovation, task orientation* and perceived innovativeness.

Strating and Nieboer (2009) have studied relationship between team climate and perceived team effectiveness in Netherland's health care quality improvement teams. It was a longitudinal study done between 2006 and 2008. Data was collected from 270 team members at the beginning and 139 members at the end of the survey. They have found that TCI has been a useful instrument to find the team climate and the team climate is a predictor of perceived team effectiveness in health care quality improvement teams. They found that the teams with good vision and participation in decision making are to achieve higher order of task performance.

Liu and Cheng (1996) have surveyed 212 administrators and information managers working in 26 teams in a 3000 bed medical center in Taiwan to find the relationship between team climate for innovation and knowledge sharing behavior. They have found that the degree of altruism and climate for participative safety are positively related to the knowledge sharing behavior.

Bosch, Dijkstra, Wensing, Weijden, and Grol (2008) have studied 83 health care professionals working in 30 primary care practices in Netherlands to find the relationship between organizational culture, team climate and quality of diabetes care. They found that the strong group culture was negatively related to the quality of diabetes care and balanced group culture was positively related to the quality of diabetes care. They did not find any relationship between organizational culture, team climate and clinical patient outcomes.

Stewart and Gosain (2006) have studied 67 free/open source software project teams using an online survey to find out the impact of team climate in terms of shared ideology and trust on team effectiveness. They found that team size and task completion have more impact in later stages of project than in early stages of project and also the effect of task completion on team effectiveness is more in later stages of project than in early stages of project. However they did not use team climate inventory as measure for team climate. They just used the variables such as trust and shared ideology.

Acuña, Gómez and Juristo (2008) have studied 35 three-member software developer teams in an academic environment in Spain to find the relationship between team climate and software product quality. They have used the team climate factors developed by Anderson and West (1998) such as team vision, task orientation, support for innovation and participative safety. They found that the high team vision and high participative safety resulted into better quality software product. According to Acuña, Gómez and Juristo (2008), team performance can not be predicted just based on individual's personality and task composition but it can be predicted using team climate characteristics.

Ganesh and Gupta (2006) have studied 25 software development teams in India having 125 team members to find the relationship of virtualness, task interdependence and extra-role performance with team climate. This is the only study in India I encountered which used Team Climate Inventory (TCI) of Anderson and West in software teams.

Ganesh and Gupta (2006) and Acuña, Gómez and Juristo (2008) are the only empirical studies I have encountered, which used team climate (TCI) as one variable in software development teams research. Other studies which used team climate were mostly in Healthcare, Banking, Telecom and Television industries.

3.2 Understanding Team Performance

Software development team performance can be measured using combination of *objective* and *subjective* measures (Sawyer, 2001; Bahli and Büyükkurt, 2005; Ong, Tan and Kankanhalli, 2005; Na, Simpson, Li, Singh and Kim, 2007). According to Sawyer (2001), *Objective* measures include function points (Ong, Tan and Kankanhalli, 2005), lines of code, defect rates, complexity metrics (Ong, Tan and Kankanhalli, 2005), resource consumption, etc. *Subjective* measures are the perceptual measures given by the people involved (Na, Simpson, Li, Singh and Kim, 2007). According to Ong, Tan and Kankanhalli (2005), other objective measures include cost variance and time variance. Perceptual measures include the assessments given by the stakeholders from outside the software development team. According to Bahli and Büyükkurt (2005), objective measures include group productivity and subjective measures include subjective ratings of the group performance. According to Hackman, group performance consists of the constructs such as task effectiveness, system viability and professional growth (Bahli and Büyükkurt, 2005). According to Ong, Tan and Kankanhalli(2005), perceptual measures include user satisfaction, teamwork satisfaction, and perceived output quality. While measuring team performance it is important to take ratings from stakeholders such as team members, management and users (Ong, Tan and Kankanhalli, 2005).

Sawyer (2001) has studied the relationship of presence of intra-group conflict, the level of conflict management and the software development team performance. He has surveyed the team members based on their most recent completed module or project. According to Sawyer (2001), constructive conflict management can improve team performance, where as destructive conflict management can reduce the team performance.

Bahli and Büyükkurt (2005) have identified, defined and measured the determinants of group performance in information systems projects. Group performance is influenced by the constructs like team building and group cohesion. Group cohesion in turn includes the task cohesion and social cohesion (Bahli and Büyükkurt, 2005). Greater team performance can be achieved through high degree of group cohesion (Rouse, 1992; Cohen and Bailey, 1997; Bahli and Büyükkurt, 2005).

Sawyer and Guinan (1998) have studied 40 software development teams at one location to find out the effects of production methods and social processes on software product quality and team performance. According to Sawyer and Guinan (1998), software development team performance consists of three attributes such as product quality, team efficiency and team effectiveness. According to them, team effectiveness and team efficiency can be assessed by stakeholders (Sawyer and Guinan, 1998; Cohen and Bailey, 1997). Also product quality can also be assed by stakeholders. Their measures of evaluating team performance include both stakeholder rated team performance and team member rated team performance. According to Sawyer and Guinan (1998), individual productivity improvements because of individual tools are indirectly linked to the software development team performance.

Huckman, Staats and Upton (2009) have studied 543 projects at Wipro, which were executed between January 2005 and September 2006 to find out the impact of team familiarity and role experience of team members on team performance. Kilo Lines of Code (KLOC) are the units of measure in all these projects. They found that the team familiarity, that is, average number of times a team member worked with other team members in the team, has positive impact on team performance. The role experience of team members, that is, the number of years a team member is in a specific role, is also results into better team performance (Huckman, Staats, and Upton, 2009). This is the study done at Wipro Technologies in India related to software development team performance. According to Huckman, Staats, and Upton(2009), team "psychological safety" impacts the team learning and team performance. Team familiarity contributes to the team psychological safety. The objective measures for software development team performance used by Huckman, Staats, and Upton (2009) include output quality and adherence to schedules and effort estimates.

According to Barry Boehm (1981), team performance can be measured using whether the project is delivered on time and on budget. According to Potok and Vouk (1999), human characteristics of the team determine the team performance.

Liang, Liu, Lin, and Lin (2007) have done a research on 30 software development teams in Taiwan to find out the relationship between knowledge diversity in team and team performance. According to them, knowledge diversity leads to task conflicts which enhances the team performance, where as value diversity leads to relationship conflicts among team members and reduces the team performance. Traditionally to study the team performance researchers have examined various personality characteristics of team members, interpersonal relationships, and interaction among team members (Liang, Liu, Lin, and Lin, 2007). In their study software development team performance is measured using Product performance and Process Performance.

Ong, Tan and Kankanhalli (2005) have studied 18 information systems development teams to find out the impact of expertise and expertise-contribution fit on team performance. The factors that affect information systems development team's performance include project size, team composition, project complexity, management support, team processes and user support (Ong, Tan and Kankanhalli, 2005). According to their research, expertise and expertise-contribution fit have significant influence on team performance.

According to Gondal and Khan (2008), top management and team leaders should identify team empowerment as a tool for enhancing team performance. According to them team performance should be rated by team members, team leaders and team external managers. Team performance is measured by meeting the quality standards, time and cost objectives. The operational concepts used to measure the team performance are effectiveness, efficiency, team conflict, mutual support, effort, learning, work satisfaction, cohesion, cooperation and coordination (Gondal and Khan, 2008).

According to Na, Simpson, Li, Singh and Kim (2007), the objective performance measures include cost, schedule and effort overrun. Na, Simpson, Li, Singh and Kim (2007) have investigated the impact of specific risk management strategies and residual performance risk on objective measures of team performance such as cost and schedule overrun with a study of 123 project teams in Korea. They found that the objective performance measures such as cost and schedule overruns are positively related to residual performance risk in Korea. Subjective performance measures of a software development team include process performance and product performance (Na, Simpson, Li, Singh and Kim, 2007; Wallace, Keil and Rai, 2004).

A related study was done by Wallace, Keil and Rai (2004) to understand the dimensions of software project risk and its impact on project performance. Their investigation showed that the social sub system risk affects the technical sub system risk, which in turn affects the level of project management risk, and finally the project performance. According to them project team performance can be measured using product performance and process performance. Product performance refers to the successfulness of the product being developed. Process performance refers to the successfulness of the development process itself (Wallace, Keil and Rai, 2004). Product performance measures used here include whether the application developed is reliable, maintainable, meets functional requirements, meets user specified response time, and overall quality of the product is high. Process performance measures used here include whether the system was completed within budget and within schedule (Wallace, Keil and Rai, 2004).

Ancona and Caldwell (1992) have studied 45 new product development teams in five high technology companies. They investigated the impact of group demography on group performance. They found that the functional and tenure diversity impact the group performance through internal process and external communication. Tenure diversity was positively related to internal process, which in turn positively affects the team performance. Functional diversity positively effects the external communication, which in turn positively affects the manager's rating of team innovation (Ancona and Caldwell, 1992; Cohen and Bailey, 1997). Team performance ratings should be given by the team members and managers (Ancona and Caldwell, 1992). Team members judge whether productive work environment exists in the team or not, where as, managers judge whether the team met the budget and schedule objectives. However both the perspectives are required to measure team performance. Ancona and Caldwell's (1992) study takes both the team members' perspective and managers' perspective in measuring team performance. There is little or no relationship between team member rated performance and manager rated performance (Ancona and Caldwell, 1992; Cohen and Bailey, 1997).

According to Cohen and Bailey (1997), team members rate the team performance high if they have healthy internal processes such as collaboration and conflict resolution. Team managers rate the team performance high if they are less intimate with internal project team dynamics and in this case they rate mainly based on the external factors.

The software development team performance diagnostic tool suggested by Pattit and Wilemon (2005) has the assessment categories such as voice of customer assessment, senior management assessment, software development process assessment, project success assessment, team leader assessment and project team assessment.

According to Kirkman, Rosen, Tesluk and Gibson (2004), process improvement and customer satisfaction are the important measures of virtual team performance. According to Freedy, McDonough, Jacobs, Freedy, Thayer, Weltman, Kalphat and Palmer (2004), team performance measure for military teams include human team processes such as shared mental models, supporting behavior, stress adaptation, situational awareness, information exchange and communication. Chudoba, Lu, Watson-Manheim and Wynn (2003) have studied teams at Intel to identify the impact of team distribution, workplace mobility and variety of work practices on team performance. They found that the being distributed had no impact on self-rated team performance. The team performance measures used in this study are interpersonal relationships, communication, team member commitment, team member participation and outcomes (Chudoba, Lu, Watson-Manheim and Wynn, 2003). In a research done by Sridhar, Paul, Nath and Kapur (2007), team member trust and communication effectiveness have positive correlation with virtual team performance. According to David F. Rico (Undated), the determinants of virtual team performance include quality of outputs, leadership, job knowledge and judgment. Mental models can also be used in finding the determinants of team performance (Rouse, 1992; Mathieu, Heffner, Goodwin, Salas and Cannon-Bowers, 2000; Bolstad and Endsley, 2000). One can use Norton & Kaplan's Balanced Score Cards (BSC) to measure entire IT department performance in an organization (Atkinson, 2004). Scott and Pollock (2006) have studied 25 information systems student teams in South Africa to explore the impact of self selected teams on team performance and team efficiency.

Basaglia, Caporarello and Magni (2009) have studied 410 team members working in 69 organizational work teams in two large European companies. They found the impact of team climate (autonomy climate and experimental climate) on IT knowledge integration capability and its impact on team performance in terms of team efficiency and team effectiveness. They found that the team climate favoring the IT knowledge integration capability affects the team efficiency and effectiveness. They observed that the positive team climate creates the new knowledge in team which in turn improves the organizational performance. They have used team climate as intermediary variable in their model.

3.3 Models of Team Performance

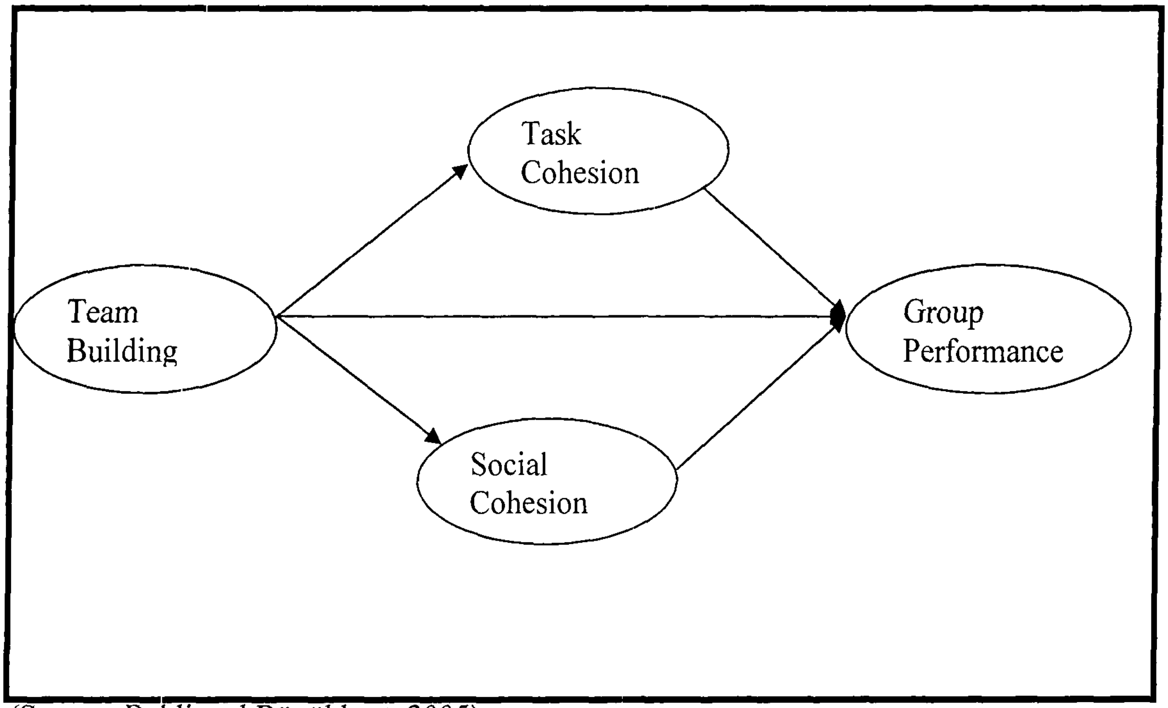
This section consists of the team performance models available in the literature.

3.3.1 Group Performance Model

Bahli and Büyükkurt (2005) have proposed a model of group performance comprising components such as Team Building, Task Cohesion, and Social Cohesion. According to Bahli and Büyükkurt (2005)'s literature review, they found that the team performance is influenced by team building, group cohesion consisting of task cohesion and social cohesion. They have developed a model (Figure 3.2) and tested the relationships between these constructs.

The objective of Bahli and Büyükkurt (2005)'s empirical study is to identify, define and measure the determinants of group performance in information systems development (ISD) projects. Their research findings indicate that team building has positive effect on both task and social cohesion. Task cohesion has effect on team performance. They also confirmed that individuals who have undertaken team building have higher degree of task cohesion. Groups having higher degree of team building have exhibited higher degree of task cohesion, which in turn, indicate better group performance (Bahli and Büyükkurt, 2005). Bahli and Büyükkurt (2005) suggest that the managers should try to focus on improving task cohesion rather than social cohesion to improve team performance.

Figure 3.2: Group Performance Model



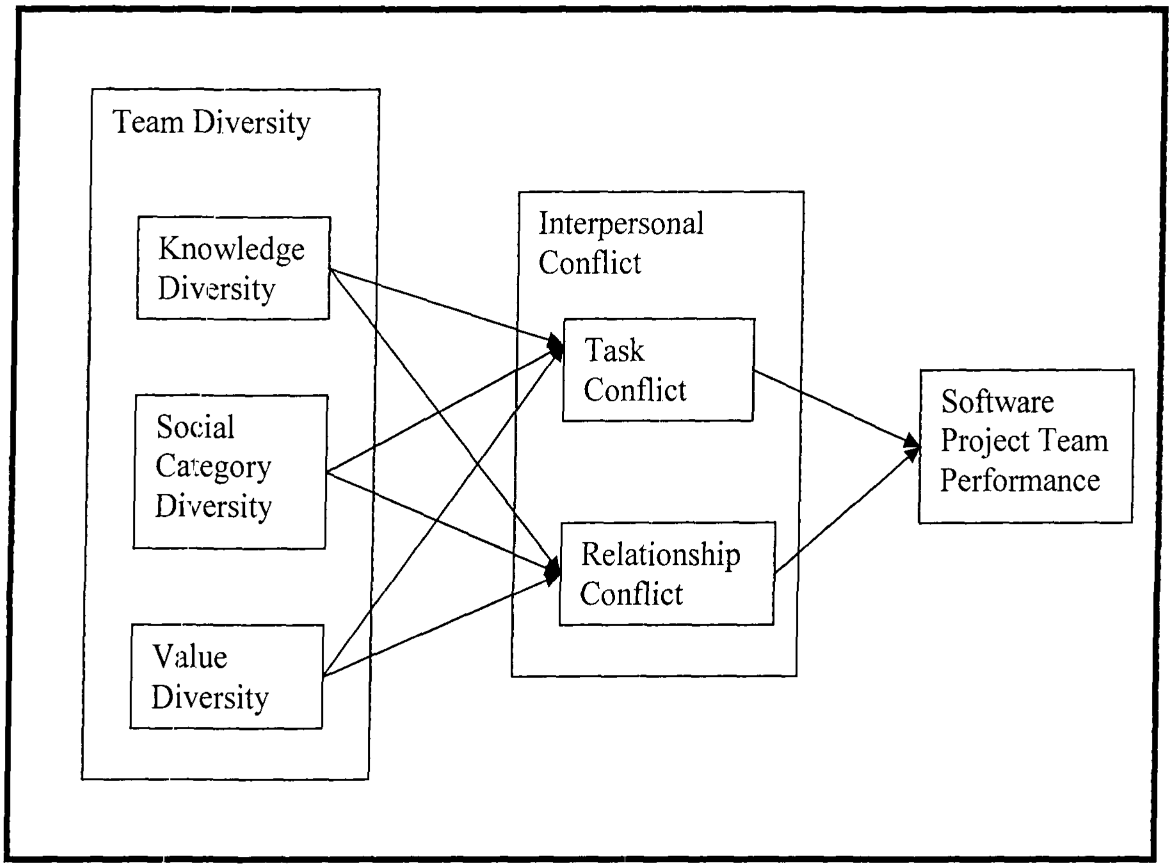
(Source: Bahli and Büyükkurt, 2005)

Bahli and Büyükkurt (2005) have taken the questionnaire items for task cohesion and social cohesion from Carless & De Paola (2000), team building from Salas et.al., (1999) and group performance from Hackman (1990).

3.3.2 Software Project Team Performance Model

The model given by Liang, Liu, Lin, and Lin (2007) has constructs such as Team performance, team diversity, and conflict. This model is developed mainly to observe the impact of team diversity and conflict on team performance. According to them software development team performance has two dimensions such as product performance and process performance. According to this model, there are three types of diversity known as knowledge, social category and value diversity which will affect the software development team performance. The conflicts given in this model include task conflict and relationship conflict. The model is as shown in the Figure 3.3.

Figure 3.3: Software Project Team Performance Model



(Source: Liang, Liu, Lin and Lin, 2007)

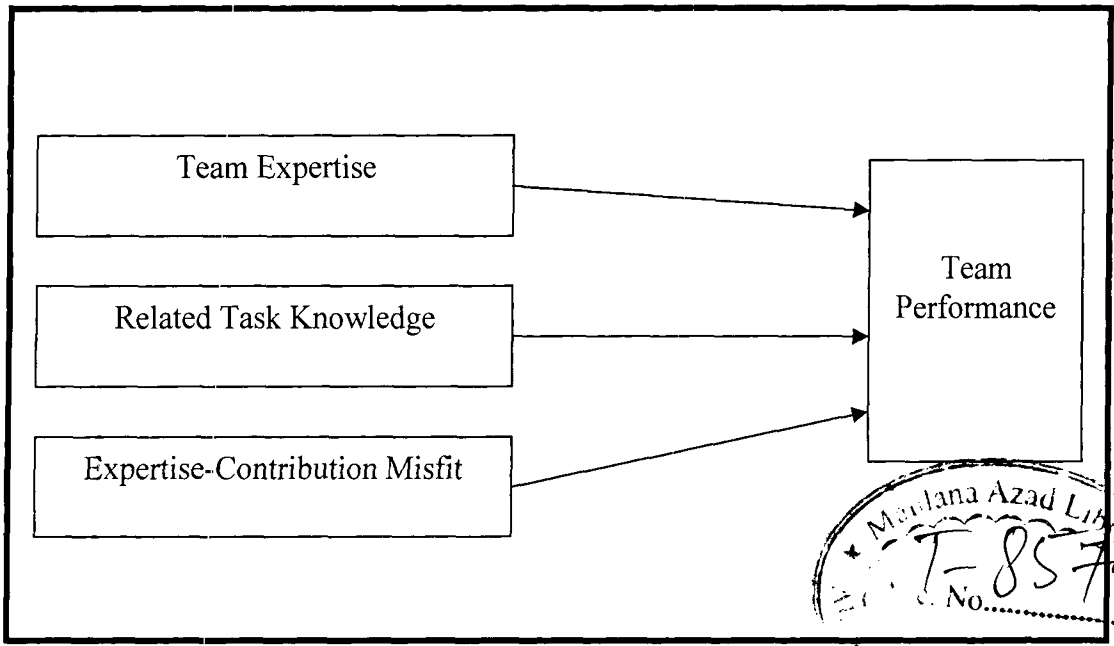
The objective of Liang, Liu, Lin, and Lin (2007)'s empirical study is to investigate the relationship between Knowledge Diversity (KD) and project performance in software teams. The earlier studies have focused on diversity issues such as age, gender and social diversity. However, Liang, Liu, Lin, and Lin (2007) have concentrated on knowledge level aiming to facilitate the knowledge management in organizations. They found that the knowledge diversity increases task conflict, which in turn has positive impact on team performance, where as value diversity (VD) increases the relationship conflict, which in turn has negative impact on team performance.

Liang, Liu, Lin, and Lin (2007) found that the value diversity is harmful to the project outcome of software development teams. They advised software project managers to form teams with members having diverse knowledge base. Liang, Liu, Lin, and Lin (2007) have used the team performance construct based on Nidumolu (1995), and knowledge diversity based on Jehn (1999). The data is collected from 30 selected software teams from Taiwanese Information Technology industry.

3.3.3 Information Systems Development Team Performance Model

The research model of team performance suggested by Ong, Tan and Kankanhalli(2005) includes antecedents such as team expertise, expertise-contribution fit (that is, how expertise are matching the assigned tasks), and related task knowledge. The model is as shown in the Figure 3.4.

Figure 3.4: Information Systems Development Team Performance Model



(Source: Ong, Tan and Kankanhalli, 2005)

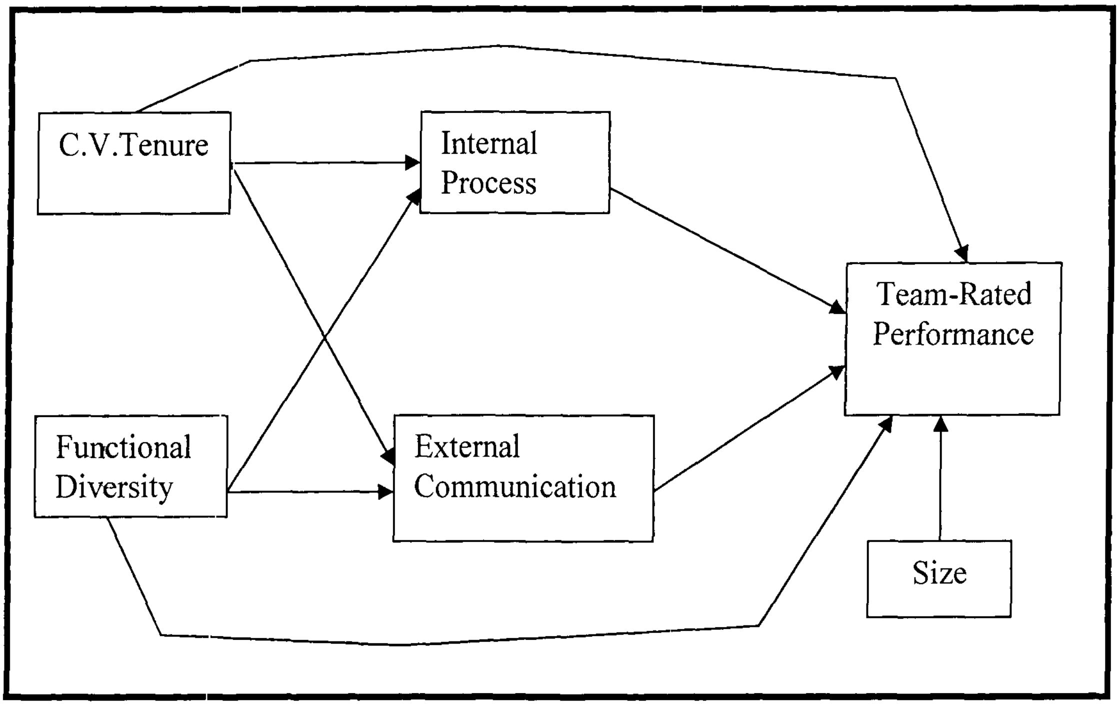
The objective of the research done by Ong, Tan and Kankanhalli(2005) is to investigate how application of expertise to an information systems (IS) development project impacts team performance. Ong, Tan and Kankanhalli(2005) have studied 18 information systems development (student) teams working on portal development projects in a large public university in Singapore. They found that the expertise and expertise-fit have significant effect on team performance and also they have highlighted the importance of matching members' expertise with contribution level to make sure the utilization of team expertise.

Ong, Tan and Kankanhalli(2005) found that the task knowledge did not show significant influence on team performance, which is a contradiction to the research study done by Bahli and Büyükkurt (2005), who found that the task cohesion has positive impact on team performance.

3.3.4 Team-rated Performance Model

The team rated performance model suggested by Ancona and Caldwell (1992) has the constructs such as C.V.tenure, functional diversity, internal process, external communication and the control variable team size. The model is as shown in the Figure 3.5.

Figure 3.5: Team-rated Performance Model



(Source: Ancona and Caldwell, 1992)

Ancona and Caldwell (1992) have done an empirical study of 45 new product teams comprising 409 individuals in five high technology companies to investigate the impact of group demography on group performance. They found that the functional and tenure diversity impact the team performance through internal process and external communication. They found that functional diversity impacts external communication which in turn influences managerial ratings of team innovation. They also found that tenure diversity impacts the internal processes, which in turn influences team ratings of performance. Ancona and Caldwell (1992) concluded by saying that diversity produces processes that facilitate performance.

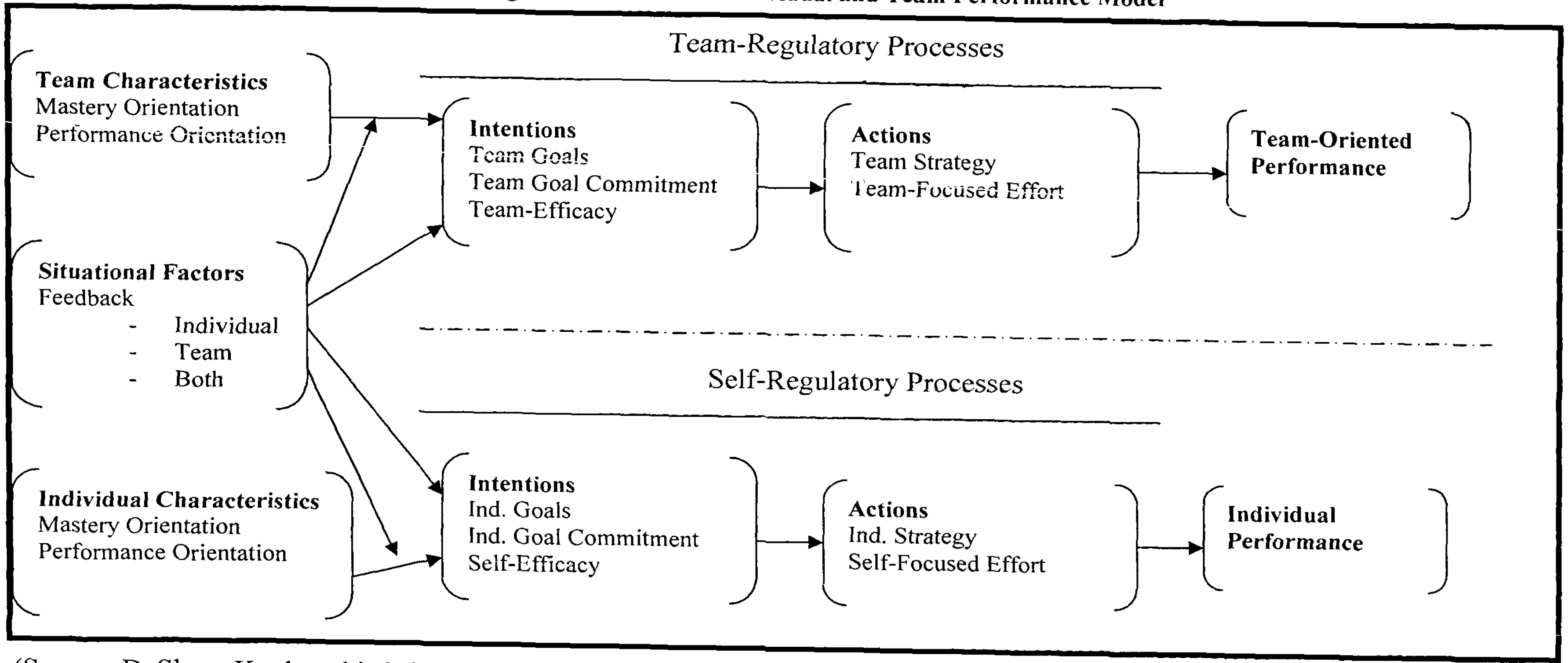
The measures of team performance used by managers in Ancona and Caldwell (1992) study are team's efficiency, quality of technical innovations, adherence to schedules, adherence to budgets, ability to resolve conflicts and the overall team performance.

The team members have rated the team performance on the items such as team efficiency, adherence to schedules, adherence to budget, quality, technical innovation, and work excellence (Ancona and Caldwell, 1992).

3.3.5 Multilevel Individual and Team Performance Process Model

This multilevel individual and team performance model was given by DeShon, Kozlowski, Schmidt, Milner and Wiechmann (2004). They have studied 79 teams that performed simulated radar task to find out the impact of goal and performance feedback on learning and performance both at individual and team level. They proposed a multilevel model as shown in Figure 3.6.

Figure 3.6: Multilevel Individual and Team Performance Model



(Source: DeShon, Kozlowski, Schmidt, Milner and Wiechmann, 2004)

The objective of the research done by DeShon, Kozlowski, Schmidt, Milner and Wiechmann (2004) is to investigate effect of performance feedback on individual and team performance. DeShon, Kozlowski, Schmidt, Milner and Wiechmann (2004) have taken individual level measures such as cognitive ability, mastery goal orientation, performance goal orientation, individual goals, individual goal commitment, self-efficacy, strategy, self-focused effort and individual performance.

DeShon, Kozlowski, Schmidt, Milner and Wiechmann (2004) have taken team level measures such as team ability, team mastery goal orientation, team performance goal orientation, team efficacy, team goals, team goal commitment, team focused effort, and team performance. They have concluded by saying that individual actions in teams can influence team performance.

3.4 Understanding Team Productivity

Wagner and Ruhe (2008a:01) have defined *Productivity* as "output divided by input". Nwelih and Amadin (2008:484) have defined *Productivity* as "a ratio of output and input". According to K.S.White (1999:317), the *Productivity* is "a measure of efficiency with which resources are employed to produce goods or services, in this case software". Scacchi (1995:03) has defined *Productivity* as "the ratio of output units produced per unit of input effort". Card (2006:01) has defined *Productivity* as "a ratio of the outputs produced to the resources consumed". According to Maxwell (2001:86), *Productivity* is defined as "output divided by the effort required to produce that output".

In the past software productivity studies were done at IBM, NASA, TRW and ITT. The software development team productivity measures should be reliable, accurate valid and repeatable (Scacchi, 1995). According to Patterson, Warr and West (2004), organizational productivity is strongly correlated to the climate aspects.

Ramasubbu and Balan (2007) have studied the impact of dispersion on team productivity and quality of distributed software development. They have studied forty two software projects which were executed at two development centers, one in India and one in US. Remote work force even with advanced technological facilities can have poor project team performance due to lack of coordination and administration (Ramasubbu and Balan, 2007).

Productivity can be defined as the ratio of function points developed to the development effort in man-hours (Ramasubbu and Balan, 2007). According to Ramasubbu and Balan (2007), Team size and Reuse are the variables affecting team productivity. Autonomy improves the team productivity for work teams but not to the project teams and group size was positively related to group productivity (Cohen and Bailey, 1997).

According to K.S.White (1999), the factors affecting the productivity of software development teams include product characteristics, people involved, processes they use and the underlying technology. A project manager can improve the productivity of the team if he manages these four areas efficiently. In software development teams, individual programmer productivity can vary by a factor of ten (White, 1999, Pinkowska, Undated) and teams' productivity can vary by a factor of five (White, 1999). Productivity improvements can be achieved by switching from low level programming languages to high level programming languages (White, 1999).

Bouchaib and Charboneau (2005) have studied 1085 projects to developed worldwide to find out the productivity differences between in-house developed projects and outsourced projects. They found that there is no significant difference in productivity levels of the projects developed in-house and projects developed by outside vendor. According to their research the productivity rate is the number of hours worked divided by the functionality provided (Bouchaib and Charboneau, 2005).

According to Scacchi (1995), little productivity improvements can lead to substantial savings to company and the major technological advancements leads to little productivity improvements. Albrecht has developed Function Points (FP) at IBM to study and measure the productivity of 24 projects (Scacchi, 1995). Project size, development environment, and programming languages can impact the software development productivity (Scacchi, 1995). Barry Boehm has conducted a study at TRW, which is based on Software Cost Estimation Program (SCEP), finally, it lead to the development of COCOMO cost estimation model. According to Boehm's study, personnel capabilities, team capabilities and product complexity have impact on the software team productivity (Scacchi, 1995). According to Boehm's study at TRW, best software teams are 4 times more productive than the worst teams (Pinkowska, Undated). According to the studies done at IBM, the response time has impact on the large scale software (LSS) development projects and the ample resources are required to achieve better software productivity (Scacchi, 1995).

According to Boehm (1981), software development team productivity is affected by the people developed the software and how they were organized and managed as a team. Software development team productivity is lower when they are poorly managed or poorly organized (Scacchi, 1995). According to Scacchi (1995), some of the attributes of highly productive software teams include small and well organized project teams, experienced software development staff, and a variety of teamwork structures.

Function Points (FP) or Lines of Code (LOC) are generally used as a measure of software productivity (Wagner and Ruhe, 2008a). According to Walston and Felix (1977), user participation, program design constraints, and programmers' experience of the programming language have impact on programming productivity. According to the study done by Lakhanpal on 31 software development teams, he found that team cohesiveness and capability have major impact on software development team productivity (Wagner and Ruhe, 2008a). According to Wagner and Ruhe(2008a), the soft factors affecting the productivity of software development teams include team identity, communication, clear goals, sense of eliteness, team cohesion, turnover, and support for innovation.

According to Tockey (1996), team size has affect on team productivity and project cost. Strong team exhibit high productivity on all the tasks assigned where as weak team exhibit low productivity over all the tasks assigned (Potok and Vouk, 1999). According to Potok and Vouk (1999), software development team productivity ranges from 500 to 1250 LOC per week.

Nwelih and Amadin (2008) defined productivity as a complex attribute of software and people. Productivity measurement can be useful for identifying under utilized resources. They have studied the impact of software reuse on software productivity. Productivity can be measured as a size of output divided by effort expended.

Table 3.2: Software Team Productivity Definitions by Different Researchers

Sl. No.	Researcher(s)	Productivity Term Used	Definition/ Formula
1.	Walston and Felix (1977)	Software Productivity	Number of lines of code produced per person hour
2.	Tausworthe (1982)	Team Productivity	Kilo lines of code / number of person months
3.	Banker and Kauffman (1991)	Productivity	(Size of Application Developed) / (Labor consumed during development)
4.	Scacchi (1995)	Software Productivity	Number of lines of source code / time in person-months
5.	Klepper, Robert, Bock and Douglas (1995) (As referred in Bouchaib and. Charboneau, 2005)	Software Productivity	Number of Source Lines of Code / Number of Programming hours or months
6.	Potok and Vouk (1999)	Team Productivity	KLOC per Calendar month
7.	Nogueira, Luqi, Berzins and Nada (2000)	Productive Ratio	% of Direct Time / % of Idle Time
8.	Maxwell and Forselius (2000)	Productivity	Function Points per hour
9.	Teasley, Covi, Krishnan and Olson (2000)	Productivity	function points per staff month
10.	Blackburn, Lapré and Van Wassenhove (2002)	Software Productivity	Function Points divided by man-months
11.	Wagner and Ruhe (2008)	Productivity	LOC or FP produced per hour by a developer
12.	Wagner and Ruhe(2008a)	Software Productivity	LOC or FP produced per man hour of developer
13.	Pressman, R.S. (2009)	Productivity	No. of function points implanted / Person-months

(Source: Researcher Compiled)

The maximum team size decreases the software development team productivity (Blackburn, Lapré and Van Wassenhove, 2002; Little, 2004; Chiang and Mookerjee, 2004; Jiang and Comstock, 2007). Blackburn, Lapré and Van Wassenhove (2002) have studied 117 software projects from a database on the Experience database provided by Software Technology Transfer in Finland. They have studied the relationship between complexity, team size and team productivity. They concluded that the complexity of software increases the team size and the large team size reduces the team productivity.

Blackburn, Lapré and Van Wassenhove (2002) have defined software productivity as project size divided by effort. Project size can be Measured in lines of code or function points. Effort is measured in man-months. According to Blackburn, Lapré and Van Wassenhove (2002), Function Points are the reliable estimate of software size because they are programming language independent. Hence, productivity is measured by dividing number of Function Points with man-months (Blackburn, Lapré and Van Wassenhove, 2002).

IEEE Standard 1045 states that the software productivity measurements should include lines of code or Function Point measures (Card, 2006).

Card (2006) defined three measures for software productivity. They are

i. Physical Productivity
ii. Functional Productivity and
iii. Economic Productivity

Physical productivity is the ratio of number of lines of code to the effort in terms of staff hours, days or months.

Functional productivity is the ratio of number function points to the effort in terms of staff hours, days or months.

Economic Productivity is the ratio of *Value* of the product produced to the *Cost* of the resources used to produce the product.

Economic Productivity = *Value / Cost*

where *Value* = *f(Price, Time, Quality, Functionality)*

From a team study, Banker, Datar and Kemerer (1991) found that teams having more experience are more productive in software maintenance projects. According to Jiang and Comstock (2007), average team size, programming language type (3GL or 4GL), development platform, and development techniques are the factors affecting the software team productivity (Jiang, Naude and Comstock, 2007). Comstock, Jiang and Naude (2007) found from a study that forth generation programming languages are more productive than third generation programming languages.

According to the study done by Banker, Datar and Kemerer(1987), the factors that positively affect the software maintenance projects productivity are project team capability and good system response time and the factors that negatively effect the software maintenance projects productivity are the lack of team application experience and high project staff loading. They have also observed the relationship between quality and productivity of software maintenance project. The factors affecting the productivity of software maintenance teams can be categorized into personnel, project management, user and technical environment. Personnel variables are the critical factors affecting the productivity of software project teams (Banker, Datar and Kemerer, 1987). Banker, Datar and Kemerer (1987) have measured the project size in FPs and SLOCs given by project leaders of 65 software maintenance projects they have surveyed at a commercial bank. According to Banker, Datar and Kemerer (1991), staff ability, quality, response time and application experience are the significant factors of productivity.

Krishnan, Kriebel, Kekre and Mukhopadhyay (1999) have observed the relationship between life-cycle productivity and conformance quality in software projects. They have also analyzed the drivers of software productivity and quality such as product size, personnel capability, usage of tools and software process factors.

Premraj, Kitchenham, Shepperd and Forselius (2005) have investigated the productivity variations between different business sectors and companies and productivity variations within a team over a period of time based on the data available in 2004 release of Experience Pro provided by Software Technology Transfer, Finland. They found that the productivity varies from business sector to business sector within the organization or with business sectors of other organizations because staff skills, process models, and development technology varies from business sector to business sector and organization to organization. According to this study the factors effecting the productivity of software teams are company, process model, business sector, year, and hardware. They have also found that there is no significant difference in productivity of development projects and maintenance projects (Premraj, Kitchenham, Shepperd and Forselius, 2005; Wagner and Ruhe, 2008).

LOC or FP is the traditional measure of output (Maxwell and Forselius, 2000; Wagner and Ruhe, 2008). Culture of innovation is useful for software development team productivity. Wagner and Ruhe (2008) assume that the vision and team goals, task orientation, support for innovation and participative safety, which constitute TCI (Team Climate Inventory) are useful for the software development team productivity as well. This has been proved true in a Swedish work group study done by Agrell and Gustafson (1994).

According to Barry Boehm's COCOMO-II, the soft factors that affect the software development team productivity are programmer capability, team cohesion, multi-site development, analyst capability, personnel turnover, programming language and tools experience (Wagner and Ruhe, 2008). According to Wagner and Ruhe(2008), productivity factors of software development teams include camaraderie (social and friendly atmosphere in the team), team identify, team cohesion, personnel turnover, clear goals, sense of eliteness, communication and support for innovation.

Technology, People and Process are the three determinants to be taken into consideration while trying to improve software development team productivity (Chiang and Mookerjee, 2004). According to Chiang and Mookerjee (2004), team productivity is determined by how well the team coordination efforts are distributed.

According to Vyhmeister, R. (1996), organizational structure, geographic location, internal politics, team morale, organizational size, program size, physical facilities, newness of the program concept, and program complexity affect the individual programmer productivity in software projects. According to him, the programmer has constraints such as financial constraints, time constraints, software specifications, programming methodology and corporate environment, which can impact programmer productivity.

Teasley, Covi, Krishnan and Olson (2000) have done an experiment to study the relationship between team collocation in warrooms and productivity. They found that the teams in warrooms have double productivity. This experiment was conducted by keeping team size from 6 to 8 so that each team fits in one room. They used function points per staff month as a measure of team productivity. They concluded that teams in warrooms are more productive than the standard teams not only in the company but also in the industry as a whole.

According Pinkowska, M. (Undated), team cohesion has major impact on software development team productivity. According to him task orientation has strong impact on team cohesion, which in turn has strong impact on team productivity and team performance. Team cohesion and team productivity are positively related. Success of individual team member in the team drives the individual motivation, team cohesion and productive atmosphere in the team. Teams with high cohesion have lower tension, and anxiety, less productivity variations, improved team member satisfaction, better communication, and commitment. In cohesive teams, people enjoy membership, experience lower turnover, and team members are very productive. In cohesive software teams, egoless programming can be found.

Banker and Kauffman (1991) have studied 20 software development projects at First Boston Corporation, an investment bank in New York to find out the relationship between reuse and productivity. They found that there is significant gain in the productivity because of source code reuse. Some large financial institutions are having productivity of 8 to 10 FPs per person month (Banker and Kauffman, 1991).

Andres (2002) have studied 46 student software development teams having four members in each team to investigate the comparison of face-to-face and virtual teams impact on team productivity, perceived interaction quality and group process satisfaction. His findings indicated the superiority of face-to-face teams in productivity than the virtual teams. He also found that the face-to-face and video conferencing settings did not have major difference in group process satisfaction. He measured the team productivity in terms of completeness of design, specification of functional prototypes and availability of pseudo code.

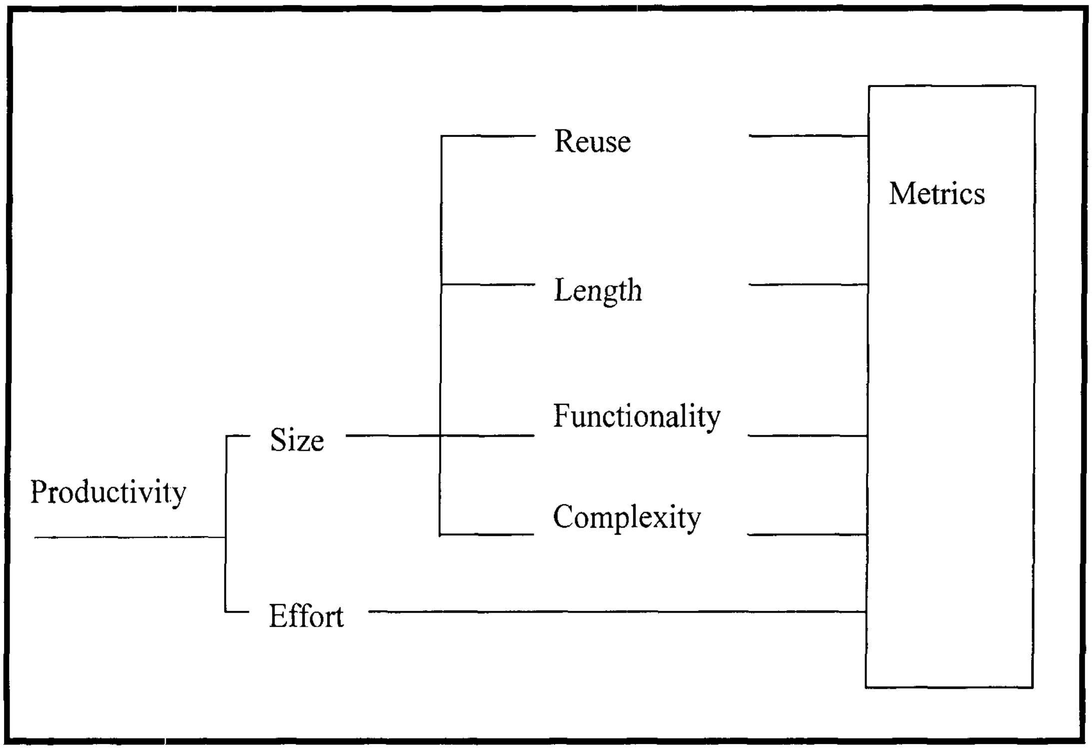
3.5 Models of Team Productivity

This section explains the team productivity models available in the literature.

3.5.1. Productivity Model including Reuse

Nwelih and Amadin (2008) have suggested a productivity model which takes software reuse into consideration. It is as shown in the Figure 3.7. According to Nwelih and Amadin (2008), productivity is defined as the ratio of output to input.

Figure 3.7: Productivity Model including Reuse



(Source: Nwelih and Amadin, 2008)

The objective of the research study of Nwelih and Amadin (2008) is to remodel the traditional software productivity model to accommodate software reuse and to find the impact of software reuse on productivity. They looked at reuse as an important aspect of productivity. The model they developed has constructs such as size, effort, reuse, length, functionality and complexity.

According to this model

$$\text{Productivity} = \sum_{i=1}^{n} (r_i + f_i + l_i + c_i) / \sum_i$$

Where

r_i = Reuse,

f_i = Functionality,

l_i = Length,

c_i = Complexity,

$\sum i$ = Effort

According to Nwelih and Amadin (2008), productivity is a function of reuse, functionality, length and complexity. This model takes the reuse, functionality, length, complexity and effort into consideration for measuring software development team productivity.

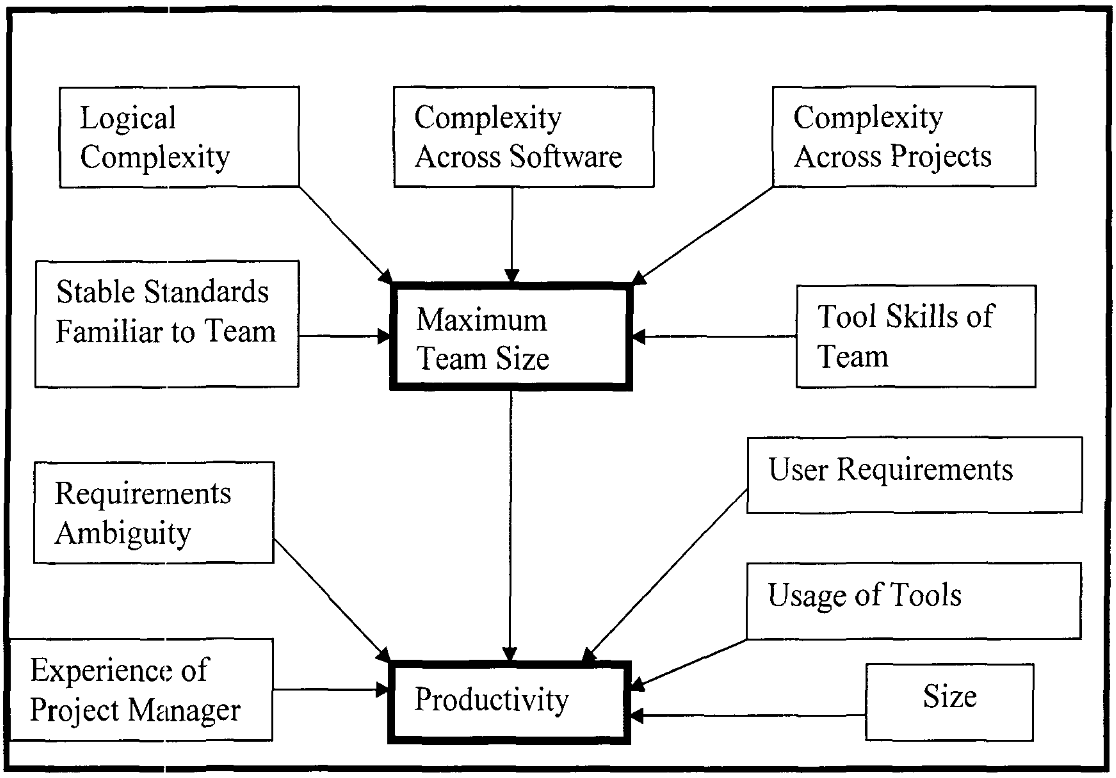
3.5.2 Maximum Team Size Model

As we know Brooks' law states that adding more people to late software project makes it later. Blackburn, Lapré and Van Wassenhove (2002) have revisited Brooks' law and investigated the impact of complexity on team size and impact of team size on software development team productivity.

With the a study of 117 software development projects in Finland, Blackburn, Lapré and Van Wassenhove (2002) have found that complexity increases the maximum team size and maximum team size decreases the team productivity.

Blackburn, Lapré and Van Wassenhove (2002) have proposed a conceptual model with complexity and other variables explaining the maximum team size; maximum team size and other variables explaining the team productivity as shown in Figure 3.8.

Figure 3.8: Maximum Team Size Model



(Source: Blackburn, Lapré and Van Wassenhove, 2002)

According to Blackburn, Lapré and Van Wassenhove (2002), software productivity is a measure of project size divided by effort. According to them Project size is to be measured in function points (FP) and effort is to be measured in man months. According to the productivity model developed by Blackburn, Lapré and Van Wassenhove (2002), the independent variables which can impact the maximum team size are logical complexity, complexity across software, complexity across projects, stable standards familiar to team, tools and skills of team.

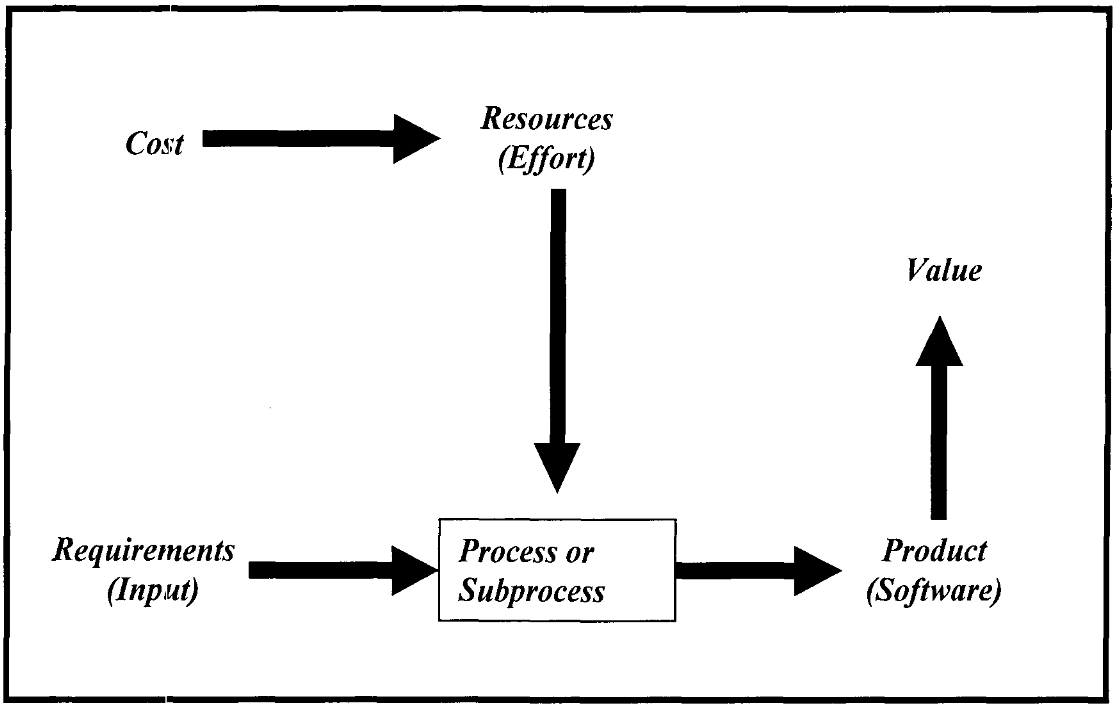
In this model, the independent variables which can impact the productivity are requirements ambiguity, experience of project manager, user requirements, usage of tools and size of the software. This is evident from the Figure 3.8.

3.5.3 Simple Model of Productivity

Card, D. N. (2006) has done secondary research to investigate the effective software productivity measures and to explore the relationship between quality and productivity of software projects.

Card, D.N. (2006) has proposed a simple model of productivity. This model has a process which converts input requirements into output product by consuming the resources such as cost, and effort. It is as shown in the Figure 3.9.

Figure 3.9: Simple Model of Productivity



(Source: Card, 2006)

The conceptual generic model proposed by Card, D.N. (2006) has constructs such as Requirements (Input), Cost, Resources (effort), Process or Sub-process, Product (Software) and Value. As per this model, the inputted Requirements are converted as Software product using process or sub-process. The process or sub-process consumes the resources such as cost and effort. According to this model, size is measured in lines of code or function points.

3.5.4 Measurement Model of Software Maintenance Projects

Banker, Datar and Kemerer (1991) have given a model to evaluate the variables impacting the productivity of software maintenance projects. They have studied 65 software maintenance projects in a large commercial bank. The factors they have used to study the impact on productivity are the team member ability, application experience, hardware, methodological tools and the resulting system quality. The proposed model for measurement of software maintenance project's productivity is as shown in Figure 3.10.

Figure 3.10: Measurement model for Software Maintenance Projects

Activity	Output Measure	Input Measure
Analysis/Design	Function Points	Total Labor Hours
Coding/Testing	Source Lines of Code	

(Source: Banker, Datar and Kemerer, 1991)

According to this model, for software maintenance projects, the productivity is measured using FPs during analysis and design phases of the projects and using number of lines of source code during coding and testing phases of the project.

3.6 Understanding Team Innovation

According to Yuan, Chaoying and Peng (2008), Innovation is the most important and interesting topic for social scientists and psychologists. Innovation became an important topic for managers working in the industry and for researchers in R & D.

West and Farr (1989:16) have defined *innovation* as "the intentional introduction and application within a role, group, or organization of ideas, processes, products or procedures, new to the relevant unit of adoption, designed to significantly benefit role performance, the group, the organization or the wider society".

According to McAdam, Reid and Gibson (2004), *innovation* is the individual and group's harnessing of creative ability in responding to change. According to Mathisen, Einarsen, Jørstad and Brønnick (2004), the zeal for creativity and innovation in products, services, systems and work processes is key factor in long term survival of an organization. According to Anderson, De Dreu, and Nijstad (2004), *Innovation* refers to the intentional introduction of news ideas and application, where as *Creativity* refers to the generation of new ideas only.

According to the research done by Jaruzelski and Dehoff of Booz Allen Hamilton in 2007, around 13.3% of the sales revenues are spent towards R & D in software industry. According to Gilson and May (2005), with innovation, Individuals and groups get some benefits such as improved productivity, increased product or service quality, improved inter personal processes and better working conditions. As per the experience of Beckman and Barry (2007), when there is need for innovation, good teams rotate leadership of the team. *Team innovation* refers to the introduction or application of new ideas, processes, products or procedures to the team. To be innovative, teams need to generate creative ideas (De Dreu and West, 2001). *Innovation* involves not only generation of creative ideas but also implementation of them.

The following Table 3.3 has the past innovation research studies on teams.

Table 3.3: Team Innovation Research Studies

Characteristic	Dimension	Research Studies
Team Structure	Minority Influence	Nemeth and Wachtler (1983); De Dreu and west (2001)
	Cohesiveness	Payne (1990)
	Longevity	Katz(1982); West and Anderson (1996)
Team Climate	Participation	West and Anderson (1996); De Dreu and West (2001)
	Vision	West and Anderson (1996); De Dreu and West (2001)
	Norms of Innovation	West and Anderson (1996); De Dreu and West (2001)
	Conflict	De Dreu and de Vries (1997)
	Constructive Controversy	Tjosvold (1988)
Team Member Characteristics	Heterogeneity of members	Nemeth and Wachtler (1983); Paulus (2000)
	Education Level	Wallach (1985)
Team Processes	Reflexivity	West, Patterson and Dawson (1999)
	Minority Dissent	De Dreu and West (2001); Taggar (2002)
	Integration Skills	Stevens and Campion (1994); Taggar (2002)
	Decision-making Style	King, Anderson and West (1992)
Leadership Style	Democratic Style	Tierney et al. (1999)
	Participative Style	Nystrom (1979); Manz, Bastien, Hostager and Shapiro (1989); Tierney et al. (1999)
	Openness to Idea Proposals	Nystrom (1990)
	Leader-Member Exchange (LMX)	Tierney et al. (1999)
	Expected Evaluation	Shalley and Perry-Smith (2001)

(Source: Anderson, De Dreu and Nijstad, 2004)

Drach-Zahavy and Somech (2001) have studied 48 intact teams in elementary and secondary schools in Israel to study the relationship of team processes and team structures to team innovation. They found that team structures and interaction processes are positively related to team innovation and the development of mutual interaction processes such as team learning are very much crucial in translating team heterogeneity into innovation.

McAdam, Reid and Gibson (2004) have done an empirical study of 2086 SMEs in Northern Ireland to find out the impact of organizational size on innovation incorporation. The result of their study indicated that organizational size has significant impact on innovation incorporation in relation to people and culture, leadership, TQM, product and process, knowledge and information management.

De Dreu and West (2001) have done an empirical research comprising of two studies to find the relationship between minority dissent and innovation in relation to team participation in decision making. Study 1 was done on self managed postal teams in Netherlands and study 2 was done on cross functional product and management teams such as local government, consulting, R & D, and financial planning and accounting teams. Both studies indicated that higher levels of minority dissent results into more innovation when there is high degree of participation in decision making. According to De Dreu and West (2001) research, it was proved that minority dissent is related to team innovation.

MacCurtain, Flood, Ramamoorthy, West and Dawson (2008) have studied 35 software firms in Ireland to know the relationship between top management team composition, knowledge sharing and innovation in organizations. They found that the top team trust, knowledge sharing and task reflexivity have both direct and indirect relationships with organizational innovation. The Organizational capacity to innovate has been related to diversity of top team, trust, reflexivity, participative leadership and knowledge sharing.

McDowell and Zhang (2009) have done a survey of 212 university seniors comprising 36 groups in a large Southwestern US university to find out the role of team cohesion in team performance and team innovation mediated by team potency. The result of their research concluded that the mediation of team potency does exist and should continue to be studied in further research. According to McDowell and Zhang (2009), innovativeness of team is one aspect of team performance.

According to Jones (2006), there are two types of innovation related to software. They are

i. Product Innovation
ii. Process Innovation

Product Innovation refers to development of new products useful to the customers. *Process Innovation* refers to the new or improved ways or methods or procedures of developing products, which reduce development time, decrease costs and improve quality (Jones, 2006).

According to Jones (2006), innovations in software can be positive or negative. Positive innovations include development of database management systems, embedded software, graphical user interfaces, medical software, search engines, word processors and web browsers. Negative innovations include computer viruses, spyware, hacking programs, etc.

According to Jones (2006), measures of internal innovations include cost, time to market, measures of quality, and measures of customer satisfaction. Measures of external innovations include patents issued to employees, market growth, market share, invention disclosures, technical publications, R & D spending, customer survey results, loss or gain of R & D jobs, and profit and revenue growth. Examples of software companies grown based on product innovation include Microsoft, IBM, Oracle, Cisco and SAP (Jones, 2006).

Eisenbeiss, Knippenberg and Boerner (2008) have studied 33 research and development teams engaged in automotive, semiconductor, packaging, and scientific instruments industries to find the relationship between transformational leadership and team innovation. They confirmed that transformational leadership predicts support for innovation, which in turn supports team innovation which is positively related to team climate. According to Eisenbeiss, Knippenberg and Boerner (2008), *team innovation* refers to the quality and quantity of new ideas generated and implemented.

According to Xue, Corrêa, Angel, Molina, Holleger and Gosch (2007), team innovation measures should include number of new ideas and quality of those ideas. According to Yilmaz (2008), Creativity and Innovation can be treated as complex adaptive system, which can be looked at individual, group and organizational level. Ebrahim, Ahmed and Taha (2009) expressed based on their secondary research that without knowledge and information capture, share, and internalization, innovation cannot be successful in R & D projects. According to Wengel, Lay, Nylund, Bager-Sjögren, Stoneman, Bellini and Shapira (2000), impact of organizational innovation on performance (Panuwatwanich, Stewart and Mohamed, 2008) and competitiveness has been increasing in current days. Galia and Legros (2002) expressed that innovation is a key factor for competitiveness. Streitz, Geiβler, Holmer, Konomi, Müller-Tomfelde, Reischl, Rexroth, Seitz and Steinmetz (1999) have done research to find the relationship between workspace arrangement and innovation. According to the study done by Malanowski (2007), the reward system in the organization has impact on behavior and outcomes of innovation.

Tushman, Smith, Wood, Westerman, O'Reilly (2006) have done a longitudinal study of 13 business units and 22 innovations to find the relationship between alternative organizational designs and streams of innovation and the nature of organizational adaptation. They investigated the consequences of organizational design structure on innovation outcomes. They found that ambidextrous organization designs are more effective than the functional, cross-functional and spinout designs.

Yiyong (2008) has done a research on 219 Chinese companies to find out the relationship between team spirit, shared vision, knowledge acquisition and product innovation. The results of the research indicated that team spirit does not have direct impact on knowledge acquisition and product innovation. However it is positively related to shared vision. Shared vision has positive indirect impact on product innovation.

Wei and Xie (2008) have done an empirical study of software firms in Hangzhou software cluster in China to find out the impact of knowledge management processes on innovation of firm. They have collected data from 205 senior executives from this cluster. They found that the knowledge management processes have significant impact on innovation performance. They also found that knowledge sharing, spillover, integration and protection could improve innovation performance of software firms in that cluster.

Galia and Legros (2002) have done an empirical research on French data set to find out the obstacles to innovation and the complementarities between those obstacles. The research found three categories of obstacles to innovation such as lack of information and rigidities, risks and costs, and problems of outlets on markets. They also found that there exist complementarities between obstacles to innovation. Complementarities found between them indicated that internal human capital and its management are keys to any innovation policy.

Panuwatwanich, Stewart and Mohamed (2008) have done a study on two Australian Architecture and Engineering Design (AED) firms to find out the role of climate for innovation comprising constructs such as organizational culture, leadership and team climate in business performance. They found that leadership is the key predictor of innovation diffusion outcomes, which in turn predict the business performance.

Huang and Wang (2002) have surveyed 260 individuals in 52 R & D teams in Taiwan to study the relationship between knowledge conversion abilities such as socialization, externalization, combination and internalization and the team innovation effectiveness, knowledge transfer, knowledge creation, and R & D performance. They found that socialization, combination, and internalization abilities of team members have positive impact on knowledge sharing, creation and transfer.

Lin (2007) has done a study of 172 employees from 50 large organizations in Taiwan to find out the influence of individual factors such as enjoyment in helping others, knowledge self-efficacy, organizational factors such as top management support and organizational rewards, and technology factors such as usage of ICT on knowledge sharing processes and innovation capability. Lin (2007) found that individual and organizational factors influence knowledge sharing processes and employee willingness to donate and collect knowledge improves the innovation capabilities.

3.7 Recent studies of Software Development Teams using TCI in India

I have come across only one empirical study on software development teams in India, which used team climate inventory (TCI). That is done by Ganesh and Gupta (2006). Ganesh and Gupta (2006) of Humanities and Social Sciences Department, IIT, Bombay have surveyed 25 software development teams consisting of 125 team members. They have studied the effect of virtualness on team climate. They have also studied the extra-role performance of team members and moderating effect of task interdependence in the relationship of virtualness and team climate. In this research team climate is the dependent variable.

Ganesh and Gupta (2006) have used Correlation analysis and ANOVA for data analysis purposes. They found that the virtualness negatively affected all the dimensions of vision scale of TCI and influence dimensions of participative safety scale of TCI. They also concluded that the task interdependence had significant main effect on Organizational Citizenship Behavior (OCB) and team climate. Task interdependence did not have any moderating effect on them. No other researcher in India has used TCI in empirical studies of software teams.

3.8 Research Gaps

Overall there are only two empirical studies which used team climate inventory (TCI) in software development teams up to my literature review findings. They are Ganesh and Gupta (2006) and Acuña, Gómez and Juristo (2008).

Ganesh and Gupta (2006) have investigated the effect of virtualness on team climate and the role of extra-role performance of team members and moderating effects of task interdependence on this relationship. They have used team climate as dependent variable.

Acuña, Gómez and Juristo (2008) have studied 35 software development teams, each team consisting of 3 team members, in an academic setup at Computer Science Department, Universidad Autónoma de Madrid, Madrid, Spain. They investigated the relationship between team climate and quality of product of software development teams. They used team climate as independent variable. They found that the vision and high participative safety dimensions of team climate are significantly related to better software. They concluded that team climate and team as one indicator of quality of the software to be delivered.

There is only one research study done on R & D teams by Bain, Mann and Pirola-Merlo (2001), which finds the relationship between team climate, team performance and team innovation. No researcher has tried to do similar research on software teams.

None of the researchers has tried to find the relationship/impact of team climate with/on team productivity, team performance and team innovation in software development teams. Also none of the researchers has tried to find the impact of team climate on team productivity, team performance and team innovation in software development teams. This current research fills this gap.

In this chapter team climate, team performance, team productivity and team innovation concepts have been introduced and explained. We have seen the different components of team climate, definitions of team productivity, meaning of team performance, when we say a team an innovative team, etc. The models of team performance, team productivity have been explained. The research gaps in the literature useful for this current study have been explained.

Next chapter is totally about research methodology. It talks about hypothesized research model of current study, research design, sample design, questionnaire design, development and administration, data collection procedure, pilot study and respondents demographic and organizational details.

Chapter 4 : RESEARCH METHODOLOGY

Chapter 4: RESEARCH METHODOLOGY

Research methodology is the heart of any research work. This chapter of this thesis explains the research problem, research objectives, research hypotheses, research design, research model, sampling design, population determination, sample frame, sampling techniques followed, determination of sample size, questionnaire design, development and administration, pilot survey, checking reliability and validity of questionnaire. Next section explains the research problem.

4.1 The Research Problem

Teams have got lot of importance in modern organizations. Many software MNCs are meeting their organizational objectives using software development teams. There are many factors that affect the productivity and performance of these software development teams (Jones, 1997). Team climate is one such factor which affects the performance of software development teams.

The research problem is to find the relationship between team climate and team performance in software development teams. The research problem is to investigate the relationship and impact of team climate on team productivity, team climate on team performance and team climate on team innovation, team productivity on team performance, team innovation on team productivity and team innovation on team performance in software development teams. It is also to find the differences on team climate, team productivity, team performance and team innovation against four demographic variables and two organizational variables.

That is to investigate whether software development team's productivity, performance and innovation are related to team climate or not and also to find out the team climate impact on them. Hence, the title of the thesis is

"The relationship between team climate and performance in software development teams".

4.2 Research Objectives

Following are the objectives of the current research.

Overall the objective is to identify and investigate the relationships among the factors/dimensions/constructs of team performance of software development teams

Detailed Objectives

1. To develop a hypothesized structural model consisting of team climate, team productivity, team performance and team innovation specific to software development teams.

2. To investigate the differences on the dimensions of team climate, team productivity, team performance and team innovation along four demographic variables such as *age, gender, educational qualifications* and *experience* in software development teams.

3. To investigate the differences on the dimensions of team climate, team productivity, team performance and team innovation along two organizational variables such as *team role* and *team size* in software development teams.

4. To investigate the relationship and impact of team climate on team productivity of software development teams.

5. To investigate the relationship and impact of team climate on team performance of software development teams.

6. To investigate the relationship and impact of team climate on team innovation of software development teams.

7. To investigate the relationship and impact of team productivity on team performance of software development teams.

8. To investigate the relationship and impact of team innovation on team productivity of software development teams.

9. To investigate the relationship and impact of team innovation on team performance of software development teams.

10. To develop a structural relationship among dimensions/constructs of team performance of software development teams

11. The objective is to make recommendations useful for Indian software industry related to team climate, team productivity, team performance and team innovation based on this research and give directions for future research.

4.3 Hypothesized Research Model

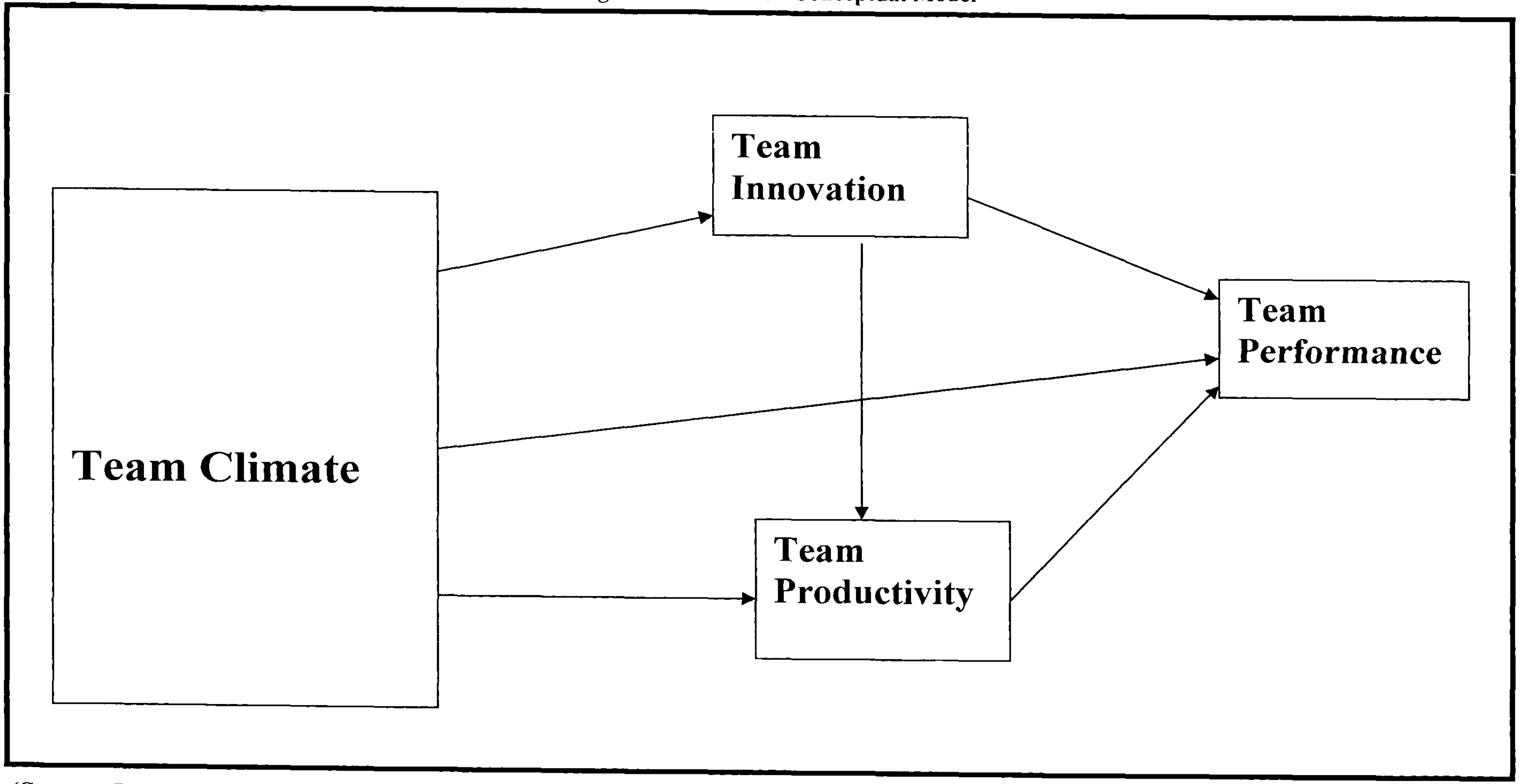
The research model consists of the variables such as *team climate*, *team productivity*, *team performance*, and *team innovation*. Team productivity, team performance and team innovation are dependent variables and team climate is the independent variable.

According to Neil R. Anderson and Michael A. West (1994), the model for *team climate* consists of the constructs such as vision, task orientation, support for innovation and participative safety. The team productivity construct is based on the instrument developed by Blackburn, Lapre and Van Wassenhove (2002).

Team performance construct is derived from Henderson and Lee (1992) and *team innovation* is derived from the work of Anderson and West (1998). The high level conceptual model of the research is as shown in Figure 4.1. The detailed conceptual model with hypotheses is as shown in Figure 4.2. The relationships between different variables to be investigated are as shown in Figure 4.1 and 4.2.

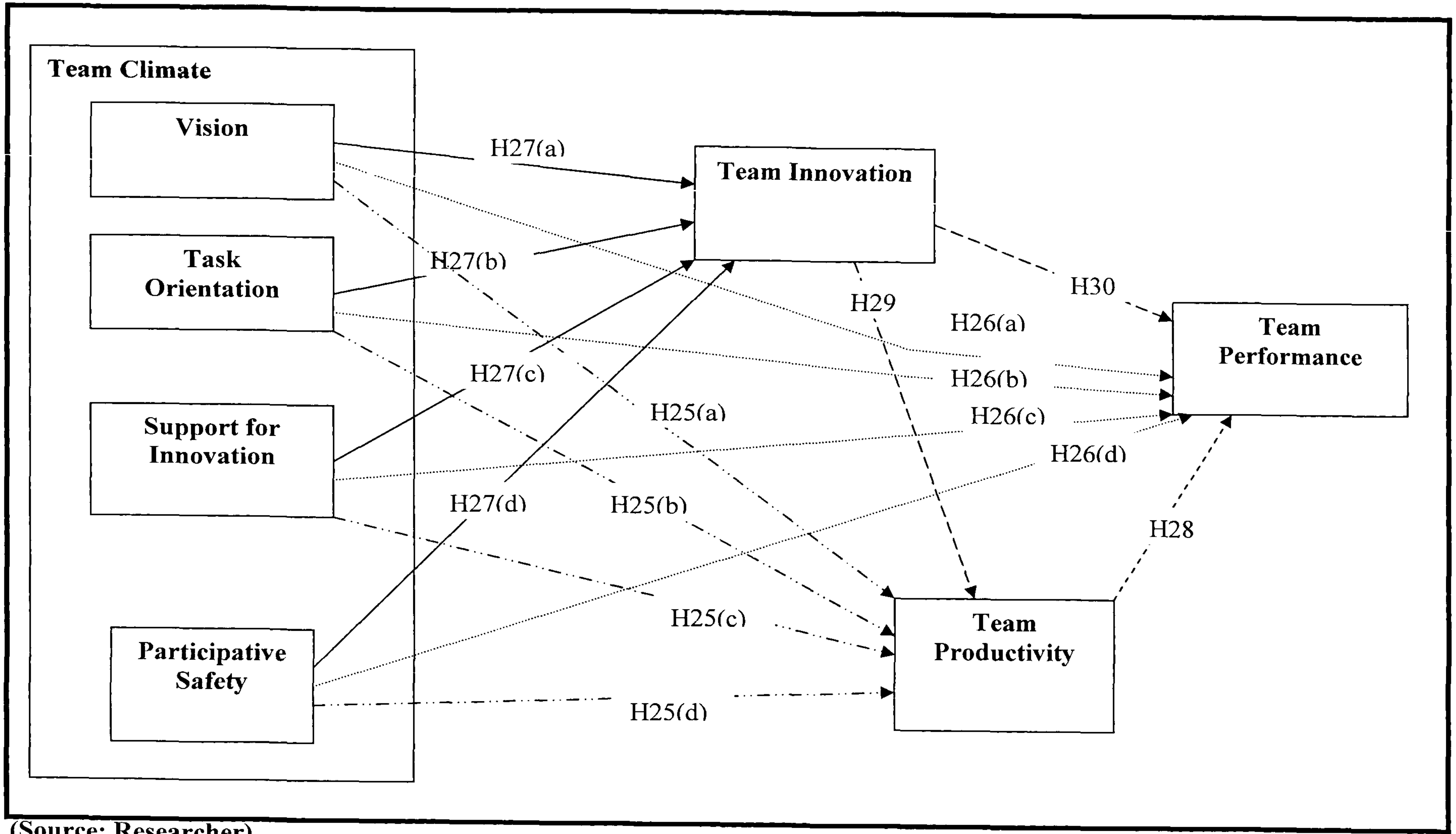
4.3.1 Hypothesized Structural Model

Figure 4.1: Research Conceptual Model



(Source: Researcher)

Figure 4.2: Detailed Research Conceptual Model



(Source: Researcher)

4.4 Research Hypotheses

4.4.1 Dimensions of Team Climate, Team Productivity, Team Performance and Team Innovation with Demographic variables (Age, Gender, Educational Qualifications and Experience)

The hypotheses to test the differences on the dimensions of team climate, team productivity, team performance and team innovation along four demographic variables such as *age, gender, educational qualifications* and *experience* in software development teams are as follows [Hypotheses H01-H16]:

a) Team Climate with Age

H01: There is no significant difference in the mean value of team climate vis-à-vis age in software development teams

H01(a): There is no significant difference in the mean value of *vision* as a dimension of team climate vis-à-vis age in software development teams

H01(b): There is no significant difference in the mean value of *task orientation* as a dimension of team climate vis-à-vis age in software development teams

H01(c): There is no significant difference in the mean value of *support for innovation* as a dimension of team climate vis-à-vis age in software development teams

H01(d): There is no significant difference in the mean value of *participative safety* as a dimension of team climate vis-à-vis age in software development teams

b) Team Productivity, Team Performance and Team Innovation with Age

H02: There is no significant difference in the mean value of team productivity vis-à-vis age in software development teams

H03: There is no significant difference in the mean value of team performance vis-à-vis age in software development teams

H04: There is no significant difference in the mean value of team innovation vis-à-vis age in software development teams

c) Team Climate with Gender

H05: There is no significant difference in the mean value of team climate vis-à-vis gender in software development teams

H05(a): There is no significant difference in the mean value of *vision* as a dimension of team climate vis-à-vis gender in software development teams

H05(b): There is no significant difference in the mean value of *task orientation* as a dimension of team climate vis-à-vis gender in software development teams

H05(c): There is no significant difference in the mean value of *support for innovation* as a dimension of team climate vis-à-vis gender in software development teams

H05(d): There is no significant difference in the mean value of *participative safety* as a dimension of team climate vis-à-vis gender in software development teams

d) Team Productivity, Team Performance and Team Innovation with Gender

H06: There is no significant difference in the mean value of team productivity vis-à-vis gender in software development teams

H07: There is no significant difference in the mean value of team performance vis-à-vis gender in software development teams

H08: There is no significant difference in the mean value of team innovation vis-à-vis gender in software development teams

e) Team Climate with Educational Qualifications

H09: There is no significant difference in the mean value of team climate vis-à-vis educational qualifications in software development teams

H09(a): There is no significant difference in the mean value of *vision* as a dimension of team climate vis-à-vis educational qualifications in software development teams

H09(b): There is no significant difference in the mean value of *task orientation* as a dimension of team climate vis-à-vis educational qualifications in software development teams

H09(c): There is no significant difference in the mean value of *support for innovation* as a dimension of team climate vis-à-vis educational qualifications in software development teams

H09(d): There is no significant difference in the mean value of *participative safety* as a dimension of team climate vis-à-vis educational qualifications in software development teams

f) Team Productivity, Team Performance and Team Innovation with Educational Qualifications

H10: There is no significant difference in the mean value of team productivity vis-à-vis educational qualifications in software development teams

H11: There is no significant difference in the mean value of team performance vis-à-vis educational qualifications in software development teams

H12: There is no significant difference in the mean value of team innovation vis-à-vis educational qualifications in software development teams

g) Team Climate with Experience

H13: There is no significant difference in the mean value of team climate vis-à-vis experience in software development teams

H13(a): There is no significant difference in the mean value of *vision* as a dimension of team climate vis-à-vis experience in software development teams

H13(b): There is no significant difference in the mean value of *task orientation* as a dimension of team climate vis-à-vis experience in software development teams

H13(c): There is no significant difference in the mean value of *support for innovation* as a dimension of team climate vis-à-vis experience in software development teams

H13(d): There is no significant difference in the mean value of *participative safety* as a dimension of team climate vis-à-vis experience in software development teams

h) Team Productivity, Team Performance and Team Innovation with Experience

H14: There is no significant difference in the mean value of team productivity vis-à-vis experience in software development teams

H15: There is no significant difference in the mean value of team performance vis-à-vis experience in software development teams

H16: There is no significant difference in the mean value of team innovation vis-à-vis experience in software development teams

4.4.2 Dimensions of Team Climate, Team Productivity, Team Performance and Team Innovation with Organizational variables (team role and team size)

The hypotheses to test the differences on the dimensions of team climate, team productivity, team performance and team innovation along two organizational variables such as *team role* and *team size* in software development teams are as follows [Hypotheses H17-H24]:

i) Team Climate with Team Role

H17: There is no significant difference in the mean value of team climate vis-à-vis team role in software development teams

H17(a): There is no significant difference in the mean value of *vision* as a dimension of team climate vis-à-vis team role in software development teams

H17(b): There is no significant difference in the mean value of *task orientation* as a dimension of team climate vis-à-vis team role in software development teams

H17(c): There is no significant difference in the mean value of *support for innovation* as a dimension of team climate vis-à-vis team role in software development teams

H17(d): There is no significant difference in the mean value of *participative safety* as a dimension of team climate vis-à-vis team role in software development teams

j) Team Productivity, Team Performance and Team Innovation with Team Role

H18: There is no significant difference in the mean value of team productivity vis-à-vis team role in software development teams

H19: There is no significant difference in the mean value of team performance vis-à-vis team role in software development teams

H20: There is no significant difference in the mean value of team innovation vis-à-vis team role in software development teams

k) Team Climate with Team Size

H21: There is no significant difference in the mean value of team climate vis-à-vis team size in software development teams

H21(a): There is no significant difference in the mean value of *vision* as a dimension of team climate vis-à-vis team size in software development teams

H21(b): There is no significant difference in the mean value of *task orientation* as a dimension of team climate vis-à-vis team size in software development teams

H21(c): There is no significant difference in the mean value of *support for innovation* as a dimension of team climate vis-à-vis team size in software development teams

H21(d): There is no significant difference in the mean value of *participative safety* as a dimension of team climate vis-à-vis team size in software development teams

l) Team Productivity, Team Performance and Team Innovation with Team Size

H22: There is no significant difference in the mean value of team productivity vis-à-vis team size in software development teams

H23: There is no significant difference in the mean value of team performance vis-à-vis team size in software development teams

H24: There is no significant difference in the mean value of team innovation vis-à-vis team size in software development teams

4.4.3 Relationships among the Constructs/Dimensions of Team Climate, Team Productivity, Team Performance and Team Innovation

The hypotheses to test the relationship between team climate and team productivity, team performance, and team innovation are given below [Hypotheses H25-H30]:

1. Relationship between Team Climate and Team Productivity

H25: There is no significant impact of team climate on team productivity in software development teams.

H25(a): There is no significant impact of *vision* as a dimension of team climate on team productivity in software development teams.

H25(b): There is no significant impact of *task orientation* as a dimension of team climate on team productivity in software development teams.

H25(c): There is no significant impact of *support for innovation* as a dimension of team climate on team productivity in software development teams.

H25(d): There is no significant impact of *participative safety* as a dimension of team climate on team productivity in software development teams.

2. Relationship between Team Climate and Team Performance

H26: There is no significant impact of team climate on team performance in software development teams.

H26(a): There is no significant impact of *vision* as a dimension of team climate on team performance in software development teams.

H26(b): There is no significant impact of *task orientation* as a dimension of team climate on team performance in software development teams.

H26(c): There is no significant impact of *support for innovation* as a dimension of team climate on team performance in software development teams.

H26(d): There is no significant impact of *participative safety* as a dimension of team climate on team performance in software development teams.

3. Relationship between Team Climate and Team Innovation:

H27: There is no significant impact of team climate on team innovation in software development teams.

H27(a): There is no significant impact of *vision* as a dimension of team climate on team innovation in software development teams.

H27(b): There is no significant impact of *task orientation* as a dimension of team climate on team innovation in software development teams.

H27(c): There is no significant impact of *support for innovation* as a dimension of team climate on team innovation in software development teams.

H27(d): There is no significant impact of *participative safety* as a dimension of team climate on team innovation in software development teams.

4. Relationship between Team Productivity and Team Performance:

H28: There is no significant impact of team productivity on team performance in software development teams.

5. Relationship between Team Innovation and Team Productivity:

H29: There is no significant impact of team innovation on team productivity in software development teams.

6. Relationship between Team Innovation and Team Performance:

H30: There is no significant impact of team innovation on team performance in software development teams.

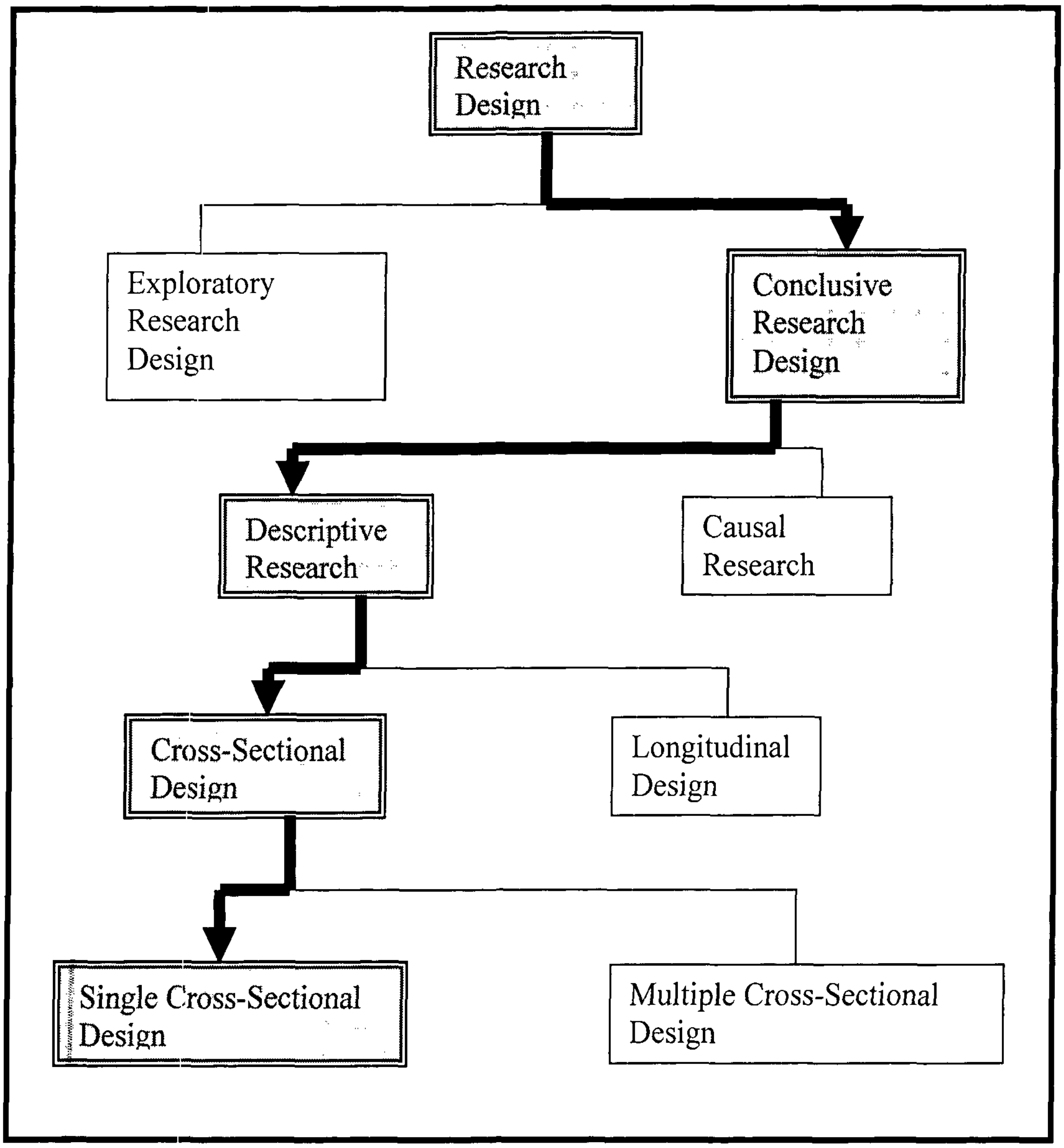
4.5 Research Design

The research design is a single cross-sectional design as shown in the Figure 4.3. The research problem is in such as way that multiple hypotheses need to be proved and relationship between different variables needs to be examined. Hence, this research comes under *conclusive research* (Malhotra, 2007).

Under conclusive research, this work belongs to *descriptive research* because of the characteristics such as it is preplanned research, structured in nature, clear research problem definition exists, specific hypotheses are available, who, when, what, why, where, and way of the research work are defined and the specific hypotheses are formulated (Malhotra, 2007).

Under descriptive research, current research comes under *cross-sectional design* because data is collected from the sample of population only once. Under cross-sectional design, this work comes under *single cross sectional design* sub category because only one sample of respondents is selected from available population and the data is collected only once. Hence, the current research work is designed as single cross sectional design.

Figure 4.3: Research Design



(Source: Malhotra, 2007)

Reasons for Selection of Software Industry

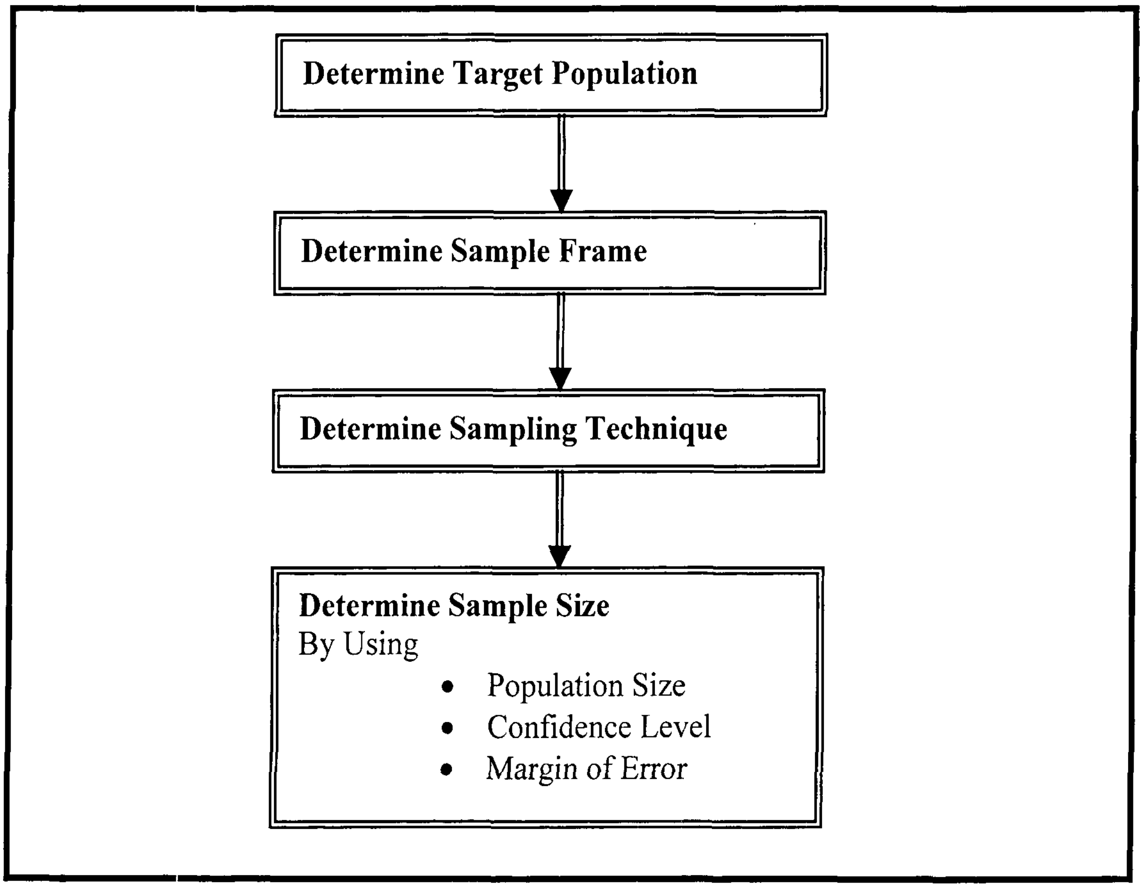
According to NASSCOM (2010) study, Indian IT industry's contribution towards GDP is around 6.1% in 2010 and its contribution towards exports is more than 25% in 2010. Software industry is the one which uses project teams to the maximum extent. Indian Software industry is the one which is continuously looking for increasing productivity of programming teams.

Researchers like Capers Jones (2007, 2008), Barry Boehm (1981), have done empirical studies on software teams. Team behavior, productivity and performance and innovation can be measured and can be improved in software development teams. Indian Software organizations are continuously trying to increase the productivity and performance of teams because of cost, profitability and quality reasons. Hence, the software industry has been chosen to do the current research on teams.

4.6 Sampling Design

This section of the thesis consists of explanation about the selection of target population, sampling frame, sampling techniques followed and determination of sample size.

Figure 4.4: Sampling Design Process



(Source: Malhotra, 2007)

Sample Size Determination

The number of software development engineers working in Hyderabad is 50,000. Others may be testing, technical support, customer support or maintenance engineers. Thus this is the target population. The sampling frame is the list of software companies registered with STP, Hyderabad. Using random sampling of six software organizations with total 382 software engineers/managers is the sample size. This is calculated for the size of population (50,000) at confidence level of 95% and margin of error at 5%. (This has been verified with sample size calculator at www.qualtrics.com)

4.7 Questionnaire Design, Development & Administration

4.7.1. Questionnaire Design and Development

Instruments for Measurement

1. **Team Climate**

   Team Climate is measured using TCI (**Team Climate Inventory**) given by Neil Anderson and Michael West (1994) – 38 Item Questionnaire with four constructs such as vision, task orientation, support for innovation and participative safety,. Detailed Questionnaire based on the above reference is in Appendix-1.

2. **Team Productivity**

   Productivity details are collected using the questions in Blackburn, Lapre and Van Wassenhove (2002).

   Productivity = Number of Function Points / Effort in Man months

3. **Team Performance**

   Team Performance is measured using a 10 (Ten) item questionnaire rated on a scale of 1-5 (1 – Strongly disagree, 3- Neutral, 5- Strongly agree) given by Henderson and Lee (1992). Detailed items based on the above reference are in Appendix-1.

4. Team Innovation

Team Innovation can be measured using 4 items adopted from Anderson & West (1998) and used in Carsten K.W. De Dreu and Michael A. West (2001). Detailed Questionnaire items based on the above reference are in Appendix-1.

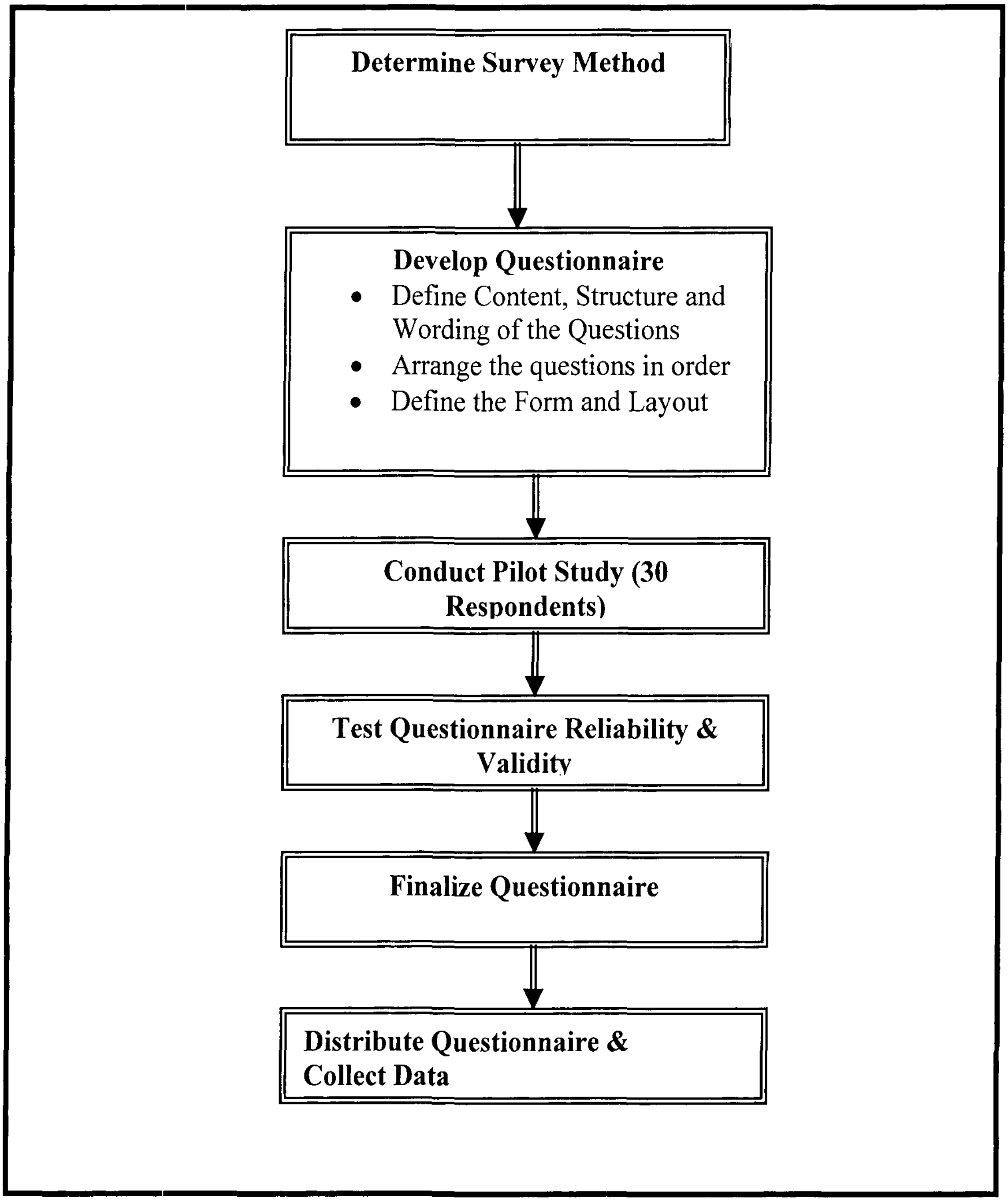
5. Demographic/ Organizational Details

Demographic details gather information about age, gender, educational qualifications, and experience level, etc. Organizational details such as name of organization, project name, team role, team size, etc are also collected. Detailed items related to demographic and organizational variables are in Appendix-1.

4.7.2 Questionnaire Administration

The basic questionnaire consists of questions related to team climate, team productivity, team performance, team innovation and demographic and organizational details respectively. Based of the literature review explained in the previous section questionnaire items are decided. Once the items in the questionnaire are finalized, a pilot study with 30 respondents was conducted. Questionnaire reliability and validity in terms of valid values is tested. Some of the items are modified in the final questionnaire. The questionnaire administration process is as shown in Fig 4.5. Finally responses were collected using an online survey website (www.kwiksurveys.com). The data is collected from 18 software development teams from 6 organizations based in Hyderabad. The teams considered for this research study are explained in the next sections.

Figure 4.5: Questionnaire Administration Process



(Source: Researcher)

The number of items in the questionnaire is as given in Table 4.1.

Table 4.1: Number of Items in the Questionnaire

Composite Variable	**Number of Items**
Team Climate	38
Team Productivity	3
Team Performance	10
Team Innovation	4
Demographic Details	11
Total No. of Questions	66

(Source: Researcher)

4.7.3 Pilot Survey

A sample of 30 responses was taken initially and responses were observed. In Team Productivity part of the questionnaire, 2nd question is related to number of kilo lines of source code (KLOC) produced by the team in a stipulated time. This KLOC varies for team to team based on the programming language they used. That is if a module implemented by team 1 takes 2000 lines in C++ programming language, second team may write the same module in just 1000 lines in Java code. Hence the productivity of both the teams can not be compared just based on the number of lines of source code they have written because the number of lines varies from programming language to programming language for the same functionality. Hence, this item has been removed from the questionnaire in final questionnaire. Hence, team productivity is calculated based on the first item function points divided by the number of man months spent to implement those specific number of function points. Thus the final questionnaire has 65 items in completeness with five parts known as team climate, team productivity, team performance, team innovation and Demographic and Organizational details.

4.7.4 Questionnaire Reliability and Validity

Questionnaire reliability was tested using Internal Consistency reliability test using the Cronbach's Alpha (Coefficient Alpha). Cronbach's Alpha is the average of all possible split half coefficients in different possible ways of splitting the scale items. Generally Cronbach Alpha values lies between 0 and 1. Cronbach Alpha value less than 0.7 indicate the unsatisfactory reliability of the questionnaire.

After pilot study of 30 responses, Cronbach Alpha was computed (Lopez, 2007). Cronbach Alpha for the entire Instrument is calculated. The details are as shown in Table 4.2.

Table 4.2: Cronbach Alpha Values for the Instrument

Instrument/Variable	Cronbach Alpha	Inter-Item Correlation
Overall Team Climate (38 items)	0.990	0.733
Vision (11 items)	0.899	0.445
Task Orientation (7 items)	0.888	0.531
Support for Innovation (8 items)	0.929	0.622
Participative Safety (12 items)	0.910	0.517
Team Productivity (3 items)	0.923	0.615
Team Performance (10 items)	0.804	0.456
Team Innovation (4 items)	0.890	0.670

(Source: Researcher)

The Cronbach Alpha values ranged between 0.804 and 0.990. This indicates the acceptable values for reliability. According to Gliem and Gliem (2003), Cronbach

Alpha values above 0.7 indicate the acceptable measure of reliability of the instrument.

Questionnaire validity is tested using *content validity*, *convergent validity* and *discriminant validity* techniques.

According to Parasuraman, Berry and Zeithaml (1991), *Content Validity* is a subjective measure concerned with the professionals in the field or domain to which the research is applicable. Hence, content validity was done through multiple discussions with the team leaders, team managers, team members, software engineers, programmers working on software development projects in the target companies. The validity of the content is verified with these professionals working in software organizations.

Convergent validity checks how the items in a construct are correlated with the related items in the same construct (Garver and Mentzer, 1999). *Divergent validity* checks the correlation of the items in a construct with the different items in different construct (Malhotra, 2007). Thus convergent validity and divergent validity checks were done by observing the correlation values between the items. In case of convergent validity, items with less than 0.5 correlation coefficient value in the same construct have been removed. In divergent validity it was made sure that the correlation coefficient value less than 0.5 between items in two different constructs.

With the Cronbach Alpha values more than 0.7 and successful content, convergent, and divergent validity checks the instrument's reliability and validity have been checked successfully.

4.8 Data Collection

Based on the statistical techniques, 382 is the ideal sample size for this research study. By keeping the low response rates for the online surveys, 550 mails were sent to team members and team leaders/managers in 6 different software organizations for questionnaire filling purpose. After repeated reminders over telephone and personal visits to these organizations 182 responses were received. Among these responses, there are 4 (four) incomplete responses which were discarded. Total 178 responses from 18 software development teams in 6 organizations were finally considered for this research study. This is approximately 32% response rate. This is the result of many personal visits to the respective organizations.

The considered teams' organization for this study is depicted in Table 4.3.

Table 4.3: Teams Organization in this Research Study

Organization Number	**Name of Organization**	**Team Number/Name**	**Team Strength (No. of Members)**
Organization 1	AAS Technologies (1 Team)	T1	2
		Sub-Total	**2**
Organization 2	Sreeven Infocom (1 Team)	T2	3
		Sub-Total	**3**
Organization 3	Tech Vedika (1 Team)	T3	5
		Sub-Total	**5**
Organization 4	CMC (5 Teams)	T4	11
		T5	8
		T6	5
		T7	9
		T8	10
		Sub-Total	**43**
Organization 5	Naresh Technologies (7 Teams)	T9	16
		T10	18
		T11	12
		T12	8
		T13	11
		T14	15
		T15	10
		Sub-Total	**90**
Organization 6	NIIT (3 Teams)	T16	16
		T17	9
		T18	10
		Sub-Total	**35**
	Total (Number of Team Members & Team Leaders/Managers)		**178**

(Source: Researcher)

Team 1 (T1) in Organization 1 was developing on a Hotel management system project. Team 2 (T2) in Organization 2 was working on Adhar Card project of Andhra Pradesh State government. Team 3 in Organization 3 is working on a software development project for a multinational publishing company with 5 member team.

Teams (T4, T5, T6, T7, T8) in Organization 4 are working on data communications and mobile communications related software development projects. Teams (T9, T10, T11, T12, T13, T14, T15) in Organization 5 are working on retail domain and health care domain projects. Teams (T16, T17, T18) in Organization Six are working on banking, financial services related software development projects.

Each team is headed by a team leader or manager and consists of team members comprising designers, architects, system analysts, programmers and software engineers.

Team size ranges from 2 to 18. Average/Mean team size is 9.8. Median team size is 10. Mode team size is 10.

Based on the data collected the respondents profile is explained in the next section.

4.9 Respondents Demographic Details

Total 178 complete responses are received from team members and team leaders of 18 software development teams. They are with different educational, skill, experience and gender backgrounds. The age group distribution of the respondents is as shown in the Table 4.4.

Table 4.4: Age Distribution

Age	Frequency	% (Percentage of Total)
< 25	138	77.53%
26-35	34	19.10%
36-45	6	3.37%
Above 46	0	0%
Total	**178**	**100%**

(Source: Researcher)

The gender distribution of respondents is as shown in Table 4.5.

Table 4.5: Gender Distribution

Gender	Frequency	% (Percentage of Total)
Male	114	64.04%
Female	64	35.96%
Total	**178**	**100%**

(Source: Researcher)

The respondents' educational qualifications are distributed as shown in Table 4.6.

Table 4.6: Educational Qualification Distribution

Qualification	Frequency	% (Percentage of Total)
Diploma/10 + 2	2	1.12%
Bachelor's Degree (B.Tech/BCA/B.Sc/B.Com)	131	73.59%
PG and Above (M.Tech/MCA/MCM/MBA/M.Sc/PhD)	45	25.28%
Total	**178**	**100%**

(Source: Researcher)

Around 10% of the respondents are team leaders or managers and 90% (approx.) are team members working in software development teams (Table 4.7).

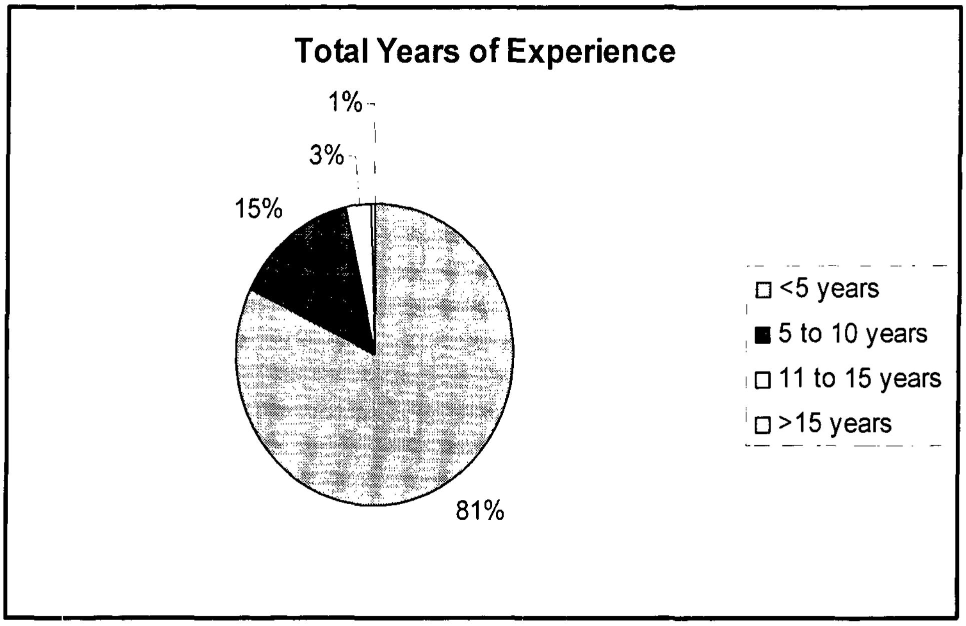
Table 4.7: Team Role Distribution

Team Role	Frequency	% (Percentage of Total)
Team Member	160	89.89%
Team Manager	18	10.11%
Total	**178**	**100%**

(Source: Researcher)

The respondents' years of experience varied largely. Their experience levels are shown in the Pie graph Fig 4.6.

Figure 4.6: Experience Levels of Respondents



(Source: Researcher Compiled)

The frequency distribution of the number of team members of the teams considered in this research study is as shown in Table 4.8.

Table 4.8: Number of Members per Team

Number of members in Team	Frequency	% of Total
1	0	0%
2	1 (T1)	5.6%
3	1 (T2)	5.6%
4	0	0%
5	2 (T3, T6)	11.1%
6	0	0%
7	0	0%
8	2 (T5, T12)	11.1%
9	2 (T7, T17)	11.1%
10	3 (T8, T15, T18)	16.7%
11	2 (T4, T13)	11.1%
12	1 (T11)	5.6%
13	0	0%
14	0	0%
15	1 (T14)	5.6%
16	2 (T9, T16)	11.1%
17	0	0%
18	1 (T10)	5.6%
19	0	0%
20	0	0%
30	0	0%
50	0	0%
100	0	0%
Total (No. of Teams)	**18**	**100%**

(Source: Researcher Compiled)

The research methodology consisting of the research conceptual model, respective hypotheses and sub-hypotheses, sampling design, questionnaire design, development and administration, pilot study, questionnaire reliability and validity, data collection procedure, data collection, teams' organization, about the teams considered for this study, and participants' demographic details are given in this chapter.

The hypotheses given in this chapter are proved in the next chapter using statistical techniques. The next chapter is about analysis of the collected data and results or findings discussion. It explains the hypotheses testing, multivariate analysis of multiple dependent variables, confirmatory factor analysis and proving relationships between team climate, team productivity, team performance and team innovation.

Chapter 5 : ANALYSIS AND DISCUSSION OF RESULTS

Chapter 5: ANALYSIS AND DISCUSSION OF RESULTS

This chapter explains how the collected data is examined, hypothesis proving using standard statistical techniques such as Karl Pearson correlation coefficient, regression coefficients, t-stat, p-values, ANOVA, and multivariate analysis of multiple dependent variables such as team productivity, team performance and team innovation. The findings of the research study are discussed in detail in this chapter.

5.1 Examination of Collected Data

Total 178 complete responses are received from team members and team managers of 18 software development teams of 6 IT organizations based in Hyderabad. Team climate, team productivity, team performance and team innovation are rated by both team leaders and team members.

The collected data was verified for completeness. It was made mandatory to answer all questions in the online questionnaire through the website. The respondents can not proceed to next page/question unless they respond to current question. With this all the questions were answered by respondents.

First, team climate was computed for each team. *Team climate* was calculated by dividing the sum of all averages of the team climate items of each response by the number of team members in that team. Similarly team performance and team innovation are also computed for each team. Team productivity is calculated by diving the number of function points implemented by the number of man months spent to implement those function points.

Finally by following the above steps the team climate, team productivity, team performance, and team innovation for each team are computed and tabulated in Table 5.1.

Table 5.1: Team Climate, Productivity, Performance, and Innovation of Each Team

Team Number	Team Climate	Team Productivity	Team Performance	Team Innovation
T1	3.348	3	3.55	2.25
T2	3.965	3.1	3.9	3.75
T3	4.136	4.55	4.24	4.5
T4	4.059	4.155	4.045	4.25
T5	3.920	3.7	3.8375	3.5
T6	3.898	3.675	3.46	3.5
T7	3.664	3	3.356	2.75
T8	3.962	3.45	3.74	3.75
T9	3.708	3.55	3.65	3.5
T10	3.746	3.6	3.644	3.25
T11	3.987	4	3.85	4
T12	3.846	3.55	3.6125	3.5
T13	3.894	3.25	3.655	3.5
T14	3.603	3	3.48	2.75
T15	4.148	4.35	4.02	4.75
T16	3.630	3.25	3.569	2.75
T17	3.787	3.5	3.727	3.25
T18	3.960	3.65	3.87	3.75

(Source: Researcher, based on Data Analysis)

The final data of each team with components of team climate such as vision, task orientation, support for innovation and participative safety and the other three dependent variables team productivity, team performance and team innovation are as shown in Table 5.2. This is the master data basically used to find correlation between two different variables.

Table 5.2: Mean Values of Team Climate Components & Team Productivity, Performance, and Innovation of Each Team

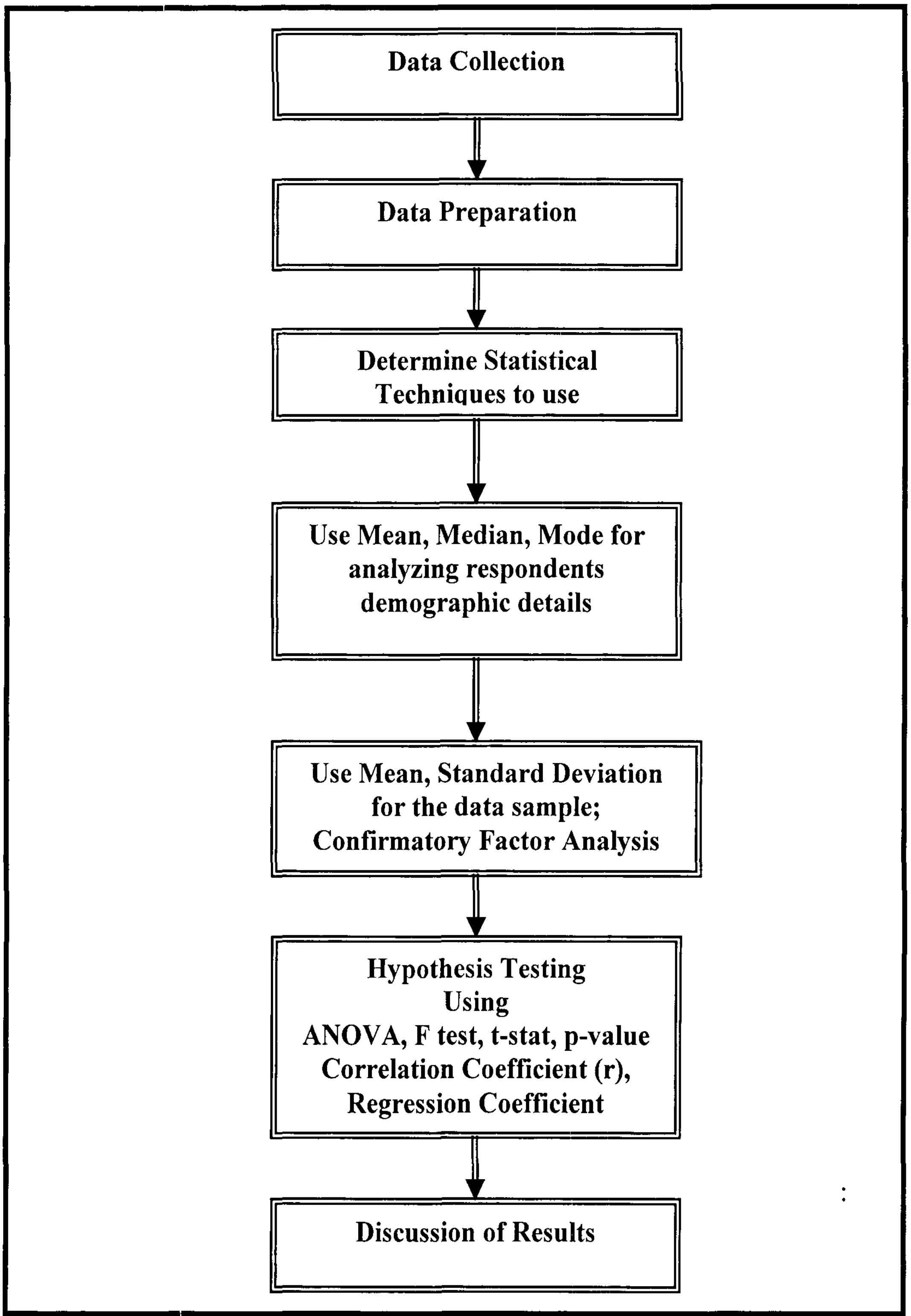
Team Number	Vision	Task Orientation	Support for Innovation	Participative Safety	Team Climate	Team Productivity	Team Performance	Team Innovation
T1	3.090	3.286	3.875	3.25	3.347	3	3.55	2.25
T2	4	3.762	4.125	3.944	3.964	3.1	3.9	3.75
T3	3.781	4.114	4.275	4.4	4.135	4.55	4.24	4.5
T4	3.992	4.026	4.057	4.152	4.059	4.155	4.045	4.25
T5	3.818	4.018	3.875	3.989	3.919	3.7	3.837	3.5
T6	3.764	4.057	3.8	4	3.898	3.675	3.46	3.5
T7	3.576	3.762	3.319	3.944	3.663	3	3.356	2.75
T8	3.818	3.986	3.95	4.1	3.962	3.45	3.74	3.75
T9	3.756	3.651	3.703	3.703	3.708	3.55	3.65	3.5
T10	3.864	3.635	3.736	3.708	3.745	3.6	3.644	3.25
T11	3.659	3.940	4.198	4.188	3.986	4	3.85	4
T12	3.602	4.054	4.031	3.813	3.846	3.55	3.612	3.5
T13	3.636	4	4.125	3.909	3.894	3.25	3.654	3.5
T14	3.612	3.676	3.55	3.583	3.603	3	3.48	2.75
T15	4.018	4.143	4.2	4.242	4.148	4.35	4.02	4.75
T16	3.739	3.786	3.352	3.625	3.629	3.25	3.568	2.75
T17	3.727	3.857	3.889	3.722	3.787	3.5	3.727	3.25
T18	3.945	4	4.025	3.9	3.960	3.65	3.87	3.75

(Source: Researcher, based on Data Analysis)

5.2 Data Analysis Procedure

The Figure 5.1 explains the data analysis procedure and the statistical techniques being used in this research study.

Figure 5.1: The Steps in Data Analysis



(Source: Researcher)

5.3 Confirmatory Factor Analysis

Factor analysis is done to check the factor loadings and their fitment into the model. Factor loadings are nothing but the correlations of the item with the variable. Factor analysis is of two types. They are Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). Exploratory factor analysis is done in the early stages of analysis just to observe the data patterns of the values of the items of latent variables. Confirmatory factor analysis is done to verify/check the hypothesis testing and fitment of the model with the data.

There are more than 30 goodness of fit indices provided by LISREL 8.5 tool. Among them, Degrees of Freedom *(df)*, Chi-Square value*(Chi)*, Root Mean Square Error of Approximation (RMSEA), Root Mean Square Residual (RMR), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI) and Parsimony Goodness of Fit Index (PGFI) are used in the current study to check the goodness of fitment of the model with the collected data.

Following is the confirmatory factor analysis of the independent variable team climate and dependent variables team productivity, team performance and team innovation.

i) Team Climate Factor Analysis

The confirmatory factor analysis of Team Climate is done using the LISREL 8.5 package for the number of responses (N=178).

The collected data underwent the exploratory factor analysis first with four factors such as *vision, task orientation, support for innovation* and *participative safety*. The summary of the statistics for the items of four factors of team climate is as shown in Table 5.3.

Table 5.3: Summary Statistics for the Independent Variable Team Climate and it's items.

Variable	Mean	St. Dev.	T Value	Skewness	Kurtosis	Minimum	Freq	Maximum	Freq
TC1	4.034	0.809	66.535	-0.774	1.112	1.000	2	5.000	52
TC2	3.966	0.856	61.794	-0.918	1.073	1.000	2	5.000	46
TC3	3.567	0.895	53.196	-0.468	0.269	1.000	4	5.000	23
TC4	3.854	0.963	53.384	-0.623	-0.159	1.000	2	5.000	49
TC5	3.590	1.050	45.624	-0.656	0.170	1.000	10	5.000	34
TC6	3.843	0.894	57.320	-0.691	0.551	1.000	3	5.000	41
TC7	3.702	0.906	54.532	-0.251	-0.485	1.000	1	5.000	36
TC8	3.758	0.993	50.485	-0.583	-0.225	1.000	3	5.000	43
TC9	3.579	1.045	45.676	-0.376	-0.376	1.000	6	5.000	38
TC10	3.719	0.962	51.555	-0.563	0.058	1.000	4	5.000	38
TC11	3.809	1.007	50.462	-0.716	0.158	1.000	5	5.000	48
TC12	3.966	1.046	50.572	-1.129	0.898	1.000	7	5.000	61
TC13	3.899	1.031	50.449	-0.890	0.306	1.000	5	5.000	56
TC14	3.826	0.996	51.246	-0.892	0.614	1.000	6	5.000	45
TC15	3.433	0.973	47.050	-0.217	-0.427	1.000	4	5.000	24
TC16	4.034	0.882	60.993	-1.064	1.445	1.000	3	5.000	55
TC17	4.084	0.985	55.320	-0.960	0.250	1.000	2	5.000	74
TC18	3.826	0.950	53.753	-0.725	0.054	1.000	2	5.000	42
TC19	3.893	1.028	50.538	-0.889	0.322	1.000	5	5.000	55
TC20	3.781	0.976	51.707	-0.839	0.643	1.000	6	5.000	40
TC21	3.730	1.006	49.482	-0.649	0.033	1.000	5	5.000	41
TC22	3.725	1.062	46.807	-0.661	-0.049	1.000	7	5.000	46
TC23	4.006	1.050	50.916	-1.138	0.917	1.000	7	5.000	67
TC24	3.753	1.113	45.000	-0.792	0.000	1.000	9	5.000	50
TC25	3.904	0.919	56.705	-0.782	0.348	1.000	2	5.000	47
TC26	3.955	0.979	53.899	-0.823	0.229	1.000	3	5.000	59
TC27	3.876	1.001	51.677	-0.775	0.307	1.000	5	5.000	54
TC28	4.056	1.024	52.871	-1.168	1.058	1.000	6	5.000	71
TC29	3.674	1.152	42.533	-0.747	-0.198	1.000	11	5.000	46
TC30	3.933	0.960	54.642	-1.065	1.122	1.000	5	5.000	50
TC31	3.798	0.988	51.292	-0.864	0.603	1.000	6	5.000	42
TC32	3.742	1.025	48.681	-0.830	0.357	1.000	7	5.000	40
TC33	3.803	0.975	52.066	-0.855	0.543	1.000	5	5.000	41
TC34	3.702	1.108	44.588	-0.724	-0.184	1.000	8	5.000	45
TC35	4.062	0.915	59.199	-1.017	0.838	1.000	2	5.000	62
TC36	3.949	1.016	51.886	-0.814	0.015	1.000	3	5.000	62
TC37	4.152	0.905	61.218	-1.277	1.774	1.000	3	5.000	70
TC38	3.826	1.109	46.036	-0.982	0.506	1.000	11	5.000	54

(Source: Researcher)

Promax-Rotated Factor Loadings (Team Climate)

Initially exploratory factor analysis was done with four factors such as vision, task orientation, support for innovation and participative safety of team climate to observe the factor loadings. This has generated four Eigen values 9.98, 2.10, 1.84 and 1.52. All the Eigen values are greater than 1.0.

The initial factor loadings of four factors are as shown in Table 5.4.

Table 5.4: Initial Factor Loadings for the four constructs of Team Climate

Item	Factor 1	Factor 2	Factor 3	Factor 4
TC1	**0.509**	-0.042	-0.086	0.173
TC2	**0.493**	0.006	-0.102	0.135
TC3	**0.413**	-0.183	0.238	-0.041
TC4	**0.285**	0.108	0.111	-0.008
TC5	**0.313**	-0.157	0.180	0.095
TC6	**0.479**	0.145	0.105	-0.223
TC7	**0.619**	-0.063	-0.056	0.001
TC8	**0.414**	0.130	0.096	-0.200
TC9	**0.285**	-0.011	0.196	-0.106
TC10	**0.540**	-0.134	0.186	-0.095
TC11	**0.455**	0.125	-0.061	0.082
TC12	0.130	**0.452**	-0.004	0.014
TC13	**0.287**	**0.363**	-0.069	-0.047
TC14	**0.290**	0.082	0.014	0.140
TC15	0.098	0.111	0.178	-0.046
TC16	0.118	**0.444**	-0.006	0.248
TC17	**0.390**	**0.325**	-0.191	0.077
TC18	0.230	**0.311**	-0.062	0.151
TC19	-0.006	**0.544**	0.081	0.219
TC20	**0.276**	**0.466**	-0.123	0.135
TC21	0.073	**0.496**	0.080	-0.070
TC22	0.012	**0.516**	0.091	-0.106
TC23	-0.144	**0.643**	**0.261**	0.109
TC24	-0.009	**0.650**	0.149	-0.099
TC25	-0.076	**0.535**	0.244	0.062
TC26	-0.089	**0.658**	0.095	0.106
TC27	0.191	-0.061	0.203	0.167
TC28	-0.013	0.107	**0.530**	0.203
TC29	0.179	0.043	**0.398**	0.050
TC30	-0.030	0.071	**0.486**	0.188
TC31	-0.049	0.150	**0.614**	0.035
TC32	0.179	0.087	**0.396**	0.014
TC33	0.130	0.145	**0.527**	-0.044
TC34	0.226	-0.015	**0.254**	**0.340**
TC35	-0.113	0.024	**0.304**	**0.502**
TC36	0.113	0.018	0.117	**0.567**
TC37	-0.064	0.197	-0.060	**0.700**
TC38	0.065	0.003	**0.253**	**0.439**
Eigen value	**9.98**	**2.10**	**1.84**	**1.52**
% Variance	**26.75**	**5.63**	**4.93**	**4.07**
Cum. % Var	**26.75**	**32.38**	**37.30**	**41.38**

(Source: Researcher)

The loading limit is considered as >= 0.25. Some of the items such as T13, T17, T20, T23, T34, T35 and T38 have been loaded on to two or more factors. Hence, these are removed and final factors analysis is done with four factors.

The final principal factor analysis with rotated factor loadings is as shown in Table 5.5.

Table 5.5: Final Rotated Factor Loadings of Team Climate

	Factor 1 (Vision)	Factor 2 (Task Orientation)	Factor 3 (Support for Innovation)	Factor 4 (Participative Safety)
TC1	**0.472**	0.093	0.090	-0.093
TC2	**0.689**	-0.060	0.112	-0.195
TC3	**0.325**	0.175	-0.167	0.160
TC4	**0.432**	0.084	0.128	-0.079
TC5	**0.510**	-0.092	-0.198	0.203
TC6	**0.087**	0.361	0.035	0.145
TC7	**0.287**	0.508	-0.011	-0.114
TC8	**-0.087**	0.773	0.057	-0.039
TC9	**0.080**	0.457	-0.058	0.045
TC10	**0.486**	0.196	-0.158	0.106
TC11	**0.403**	0.046	0.204	-0.038
TC12	-0.026	**0.168**	0.476	-0.024
TC14	0.290	**-0.013**	0.131	0.090
TC15	0.145	**-0.065**	0.081	0.165
TC16	0.174	**-0.151**	0.523	0.122
TC18	0.088	**0.079**	0.411	0.009
TC19	0.049	-0.073	**0.623**	0.130
TC21	-0.146	0.206	**0.548**	-0.002
TC22	-0.057	0.056	**0.491**	0.022
TC24	-0.003	0.163	**0.548**	-0.003
TC25	0.084	-0.052	**0.571**	0.093
TC26	-0.007	0.023	**0.741**	-0.040
TC27	0.076	0.105	0.097	**0.190**
TC28	0.204	-0.199	0.119	**0.579**
TC29	0.117	0.086	0.068	**0.389**
TC30	-0.133	0.083	0.159	**0.516**
TC31	-0.122	-0.007	0.051	**0.755**
TC32	0.064	0.019	-0.031	**0.589**
TC33	-0.057	0.139	0.166	**0.512**
TC36	0.176	-0.029	0.320	**0.173**
TC37	0.211	-0.199	0.453	**0.054**
Eigen value	**7.74**	**1.88**	**1.59**	**1.38**
% Variance	**25.85**	**6.27**	**5.30**	**4.62**
Cum. % Var	**25.85**	**32.12**	**37.42**	**42.04**
Cronbach Alpha	**0.899**	**0.888**	**0.929**	**0.910**

(Source: Researcher)

The final rotated factor analysis generated four Eigen values 7.74, 1.88, 1.59 and 1.38. All the generated Eigen values are greater than 1.0. The inter correlations between the four factors are as shown in Table 5.6.

Table 5.6: Inter Correlations of Team Climate Factors

	Factor 1 (Vision)	**Factor 2 (Task Orientation)**	**Factor 3 (Support for Innovation)**	**Factor 4 (Participative Safety)**
Factor 1 (Vision)	1.000			
Factor 2 (Task Orientation)	0.420	1.000		
Factor 3 (Support for Innovation)	0.479	0.391	1.000	
Factor 4 (Participative Safety)	0.574	0.421	0.559	1.000

(Source: Researcher)

Confirmatory Factor Analysis of Team Climate

The final confirmatory factor analysis of four factors of Team Climate has resulted into the following statistics (Table 5.7).

Table 5.7: Confirmatory Factor Analysis of Team Climate

Goodness of Fit Statistics		
Specific Index	**Observed Value**	**Recommended Values**
Degrees of Freedom *(df)*	465	
Minimum Fit Function Chi-Square *(Chi)*	1896.996 (P = 0.0)	*(Chi/df)* < 3.0
Root Mean Square Error of Approximation (RMSEA)	0.232	<0.08 (Garson, 2007)
90 Percent Confidence Interval for RMSEA	(0.226 ; 0.238)	
Root Mean Square Residual (RMR)	0.236	< 0.1 (Garson, 2007)
Goodness of Fit Index (GFI)	0.359	> 0.0
Adjusted Goodness of Fit Index (AGFI)	0.316	0.0 to 1.0 (Garson, 2007)
Parsimony Goodness of Fit Index (PGFI)	0.336	The greater the best (Garson, 2007)

The Chi-Square value (1896.996) divided by degrees of freedom (465) is 4.079. The best fit should have *Chi/df* less than 3.0. However, the observed calculated value is close to critical value 3.0 with a gap of 1.07, which is acceptable. The critical RMSEA value should be < 0.08 (Garson, 2007). RMR value should be close to zero. However, Adjusted Goodness of Fit Index (AGFI) is in between 0.0 and 1.0. Thus *Chi/df* is close to 3.0 and AGFI (0.316) is in between 0 and 1 (Garson, 2007). Hence, the model is acceptable. Cronbach Alpha of all the four factors (0.899, 0.888, 0.929, 0.910) is greater than 0.7. According to Gliem and Gliem (2003), Cronbach Alpha greater than 0.7 indicates that the instrument is reliable.

ii) Team Productivity Confirmatory Factor Analysis

Team productivity, a dependent variable, has basically three items (TY1, TY2, TY3) corresponding to number of function points, number of KLOCs (Kilo Lines of Code) and number of man months of effort respectively. However the number of kilo lines of code is removed (TY2) from the CFA because the productivity of software teams varies from programming language to programming language. Hence, measure of KLOC (Kilo Lines of Code) is removed from the CFA. Other two items (TY1, TY3) have ordinal values (number of function points, number of man months).

The summary statistics for the team productivity items data is as shown in Table 5.8.

Table 5.8: Summary Statistics for Team Productivity Variables

Variable	Mean	St. Dev.	T Value	Skewness	Kurtosis	Minimum	Freq	Maximum	Freq
TY1	260.667	118.827	9.307	-0.461	-0.620	31.000	1	444.000	1
TY3	14.778	7.216	8.689	-0.158	-0.785	2.000	1	27.000	1

Number of function points implemented varied from 31 to 444 and man months spent on that work varied from 2 to 27. Mean number of function points implemented is 260.667 and mean man months spent is 14.778. The inter correlation values for the items of team productivity is as shown in Table 5.9.

Table 5.9: Inter Correlation Values between the Items of Team Productivity

Item	TY1	TY3
TY1	1.000	
TY3	0.968	1.000

The correlation value (0.968) indicates the strong correlation between number of function points implemented (TY1) and the number of man months spent (TY3). The result of confirmatory factor analysis of the items of the variable team productivity is as shown in Table 5.10.

Table 5.10: Confirmatory Factor Analysis of Team Productivity

Goodness of Fit Statistics	
Specific Index	**Value**
Degrees of Freedom	1
Minimum Fit Function Chi-Square	47.116
Root Mean Square Error of Approximation (RMSEA)	0.937
90 Percent Confidence Interval for RMSEA	(0.569 ; 1.367)
Root Mean Square Residual (RMR)	0.559
Goodness of Fit Index (GFI)	0.516
Adjusted Goodness of Fit Index (AGFI)	-0.452
Parsimony Goodness of Fit Index (PGFI)	0.172
Cronbach Alpha	0.923

The calculated Chi-Square value (47.116) divided by degrees of freedom (1) is much more than 3.0. This is because the items in the team productivity are not continuous variables, they are ordinal in nature. Goodness of fit index (GFI) is more than 0.5 and the Cronbach Alpha value (0.923) is more than 0.7.

iii) Team Performance Factor Analysis

Another dependent variable is Team performance. Team performance has ten items (TPR1-TPR10). The summary statistics of team performance items are as shown in Table 5.11.

Table 5.11: Summary Statistics for items of Team Performance

Variable	Mean	St. Dev.	T Value	Skewness	Kurtosis	Minimum	Freq	Maximum	Freq
TPR1	3.989	0.864	61.629	-0.777	0.690	1.000	2	5.000	52
TPR2	4.017	0.840	63.785	-0.841	1.014	1.000	2	5.000	52
TPR3	3.517	0.928	50.558	-0.393	-0.053	1.000	4	5.000	23
TPR4	3.888	0.914	56.769	-0.629	0.111	1.000	2	5.000	48
TPR5	4.140	0.913	60.515	-1.049	0.853	1.000	2	5.000	73
TPR6	3.669	0.967	50.625	-0.620	0.185	1.000	5	5.000	33
TPR7	3.584	0.893	53.533	-0.425	0.290	1.000	4	5.000	25
TPR8	3.635	1.012	47.921	-0.572	-0.035	1.000	6	5.000	35
TPR9	2.904	1.113	34.807	0.017	-0.653	1.000	21	5.000	14
TPR10	3.719	0.980	50.637	-0.722	0.555	1.000	7	5.000	38

Maximum likelihood factor analysis for 1 Factor, team performance is done. This factor analysis generated one Eigen value (2.84), which is greater than 1.0. The final factor loadings are as shown in Table 5.12.

Table 5.12: Team Performance Final Factor Loadings

Item	Factor 1	Unique Var
TPR1	**0.599**	0.641
TPR2	**0.763**	0.417
TPR3	**0.359**	0.871
TPR4	**0.395**	0.844
TPR5	**0.604**	0.636
TPR6	**0.556**	0.691
TPR7	**0.464**	0.785
TPR8	**0.457**	0.791
TPR9	0.105	0.989
TPR10	**0.558**	0.689
Eigen value	2.84	
% Variance	31.81	
Cum. % Var	31.81	

Because all the factor loadings are greater than 0.25 (except TPR9), these factor loadings are straight away considered. The correlations between individual variables and the component variable team performance are as shown in the Table 5.13. Inter correlations between all 10 items of team performance are as shown in Table 5.14.

Table 5.13: Correlations between Variables and Principal Component Team Performance

Item	Correlation Coefficient
TPR1	0.568
TPR2	0.717
TPR3	0.465
TPR4	0.508
TPR5	0.629
TPR6	0.666
TPR7	0.558
TPR8	0.589
TPR9	0.229
TPR10	0.664

Table 5.14: Inter Correlation Values between Items of Team Performance

	TPR1	TPR2	TPR3	TPR4	TPR5	TPR6	TPR7	TPR8	TPR9	TPR10
TPR1	1									
TPR2	0.577	1								
TPR3	0.106	0.271	1							
TPR4	0.084	0.253	0.302	1						
TPR5	0.425	0.476	0.181	0.290	1					
TPR6	0.259	0.362	0.268	0.220	0.418	1				
TPR7	0.184	0.326	0.158	0.233	0.211	0.337	1			
TPR8	0.280	0.300	0.184	0.255	0.233	0.199	0.337	1		
TPR9	0.034	-0.010	0.163	0.050	0.041	0.175	0.022	0.074	1	
TPR10	0.277	0.431	0.192	0.274	0.221	0.372	0.324	0.318	0.136	1

Confirmatory Factor Analysis of Team Performance

The final confirmatory factor analysis of team performance has given the statistical indices as shown in Table 5.15.

Table 5.15: Confirmatory Factor Analysis of Team Performance

Goodness of Fit Statistics	
Specific Index	**Value**
Degrees of Freedom	35
Minimum Fit Function Chi-Square	77.23
Root Mean Square Error of Approximation (RMSEA)	0.260
90 Percent Confidence Interval for RMSEA	(0.242 ; 0.279)
Root Mean Square Residual (RMR)	0.245
Standardized RMR	0.245
Goodness of Fit Index (GFI)	0.602
Adjusted Goodness of Fit Index (AGFI)	0.514
Parsimony Goodness of Fit Index (PGFI)	0.493
Cronbach Alpha	0.804

The Chi-Square Value (77.23) divided by degrees of freedom (35) is (2.206) less than 3. Adjusted Goodness of Fit Index (AGFI) is in between 0 and 1. Cornbach Alpha value (0.804) is greater than 0.7. Hence, the model can be accepted and it is best fit.

iv) Team Innovation Factor Analysis

Team innovation is another dependent variable. There are four items (TI1-TI4) in this component variable. The summary statistics of the variables data is as shown in Table 5.16.

Table 5.16: Summary Statistics of Team Innovation Items

Variable	Mean	St. Dev.	T Value	Skewness	Kurtosis	Minimum	Freq	Maximum	Freq
TI1	3.889	0.963	17.126	0.645	0.211	2.000	2	5.000	5
TI2	3.500	0.786	18.894	0.409	0.069	2.000	2	5.000	1
TI3	3.000	1.029	12.369	0.364	1.369	1.000	1	4.000	8
TI4	3.667	1.029	15.118	0.324	0.871	2.000	3	5.000	4

Maximum Likelihood Factor Analysis for 1 Factor, Team Innovation is done and the final factor loadings are as shown in Table 5.17.

Table 5.17: Team Innovation Final Factor Loadings

Item	**Factor 1**	**Unique Var**
TI1	0.117	0.986
TI2	**0.463**	0.786
TI3	**0.791**	0.374
TI4	**0.774**	0.401
Eigen value	1.87	
% Variance	50.91	
Cum. % Var	50.91	

All the factor loadings (except TI1) are greater than 0.25. Hence these factor loadings are directly considered for confirmatory factor analysis. The correlations between variables and the principal component team innovation are as shown in Table 5.18. Inter item correlations among variables of team innovation are shown in Table 5.19.

Table 5.18: Correlations between Variables and Principal Component Team Innovation

Item	**Correlation Coefficient**
TI1	-0.197
TI2	0.544
TI3	0.884
TI4	0.879

Table 5.19: Inter Correlation Values between Items of Team Innovation

	TI1	TI2	TI3	TI4
TI1	1			
TI2	0	1		
TI3	0.119	0.364	1	
TI4	0.080	0.364	0.611	1

The results of confirmatory factor analysis of one factor team innovation with four items are as shown in Table 5.20.

Table 5.20: Confirmatory Factor Analysis of Team Innovation

Goodness of Fit Statistics	
Specific Index	**Value**
Degrees of Freedom	2
Minimum Fit Function Chi-Square	0.09
Root Mean Square Error of Approximation (RMSEA)	0.226
90 Percent Confidence Interval for RMSEA	(0.0; 0.428)
Root Mean Square Residual (RMR)	0.257
Standardized RMR	0.257
Goodness of Fit Index (GFI)	0.752
Adjusted Goodness of Fit Index (AGFI)	0.587
Parsimony Goodness of Fit Index (PGFI)	0.451
Cronbach Alpha	0.890

The Chi-Square value (0.09) divided by degrees of freedom (2) is (0.045) less than 3.0. The Adjusted Goodness of fit index (AGFI) is in between 0 and 1 and the Cronbach Alpha value (0.890) is greater than 0.7. This indicates that the model is acceptable.

Summary of Confirmatory Factor Analysis

The summary of the confirmatory factor analysis of all the factors such as team climate, team productivity, team performance and team innovation are as shown in Table 5.21.

Table 5.21: Summary of Confirmatory Factor Analysis

Model	Chi-Square (*Chi*)	Degrees of Freedom (*df*)	*Chi/df*	RMSEA	Goodness of Fit Index (GFI)
4 Factors, Correlated (*Team Climate*)	1896.996	465	4.07	0.232	0.359
1 Factor (*Team Productivity*)	47.116	1	47.116	0.937	0.516
1 Factor (*Team Performance*)	77.23	35	2.20	0.260	0.602
1 Factor (*Team Innovation*)	0.09	2	0.045	0.226	0.752

5.4 Hypothesis Testing

The Hypotheses are tested using the statistical techniques such as ANOVA, t-test, F test, Correlation and regression. Following is the testing the respective hypotheses and interpretation of the hypotheses supported or not supported.

5.4.1 Dimensions of Team Climate, Team Productivity, Team Performance and Team Innovation with Demographic variables (Age, Gender, Educational Qualifications and Experience)

a) Team climate with Age

Hypothesis H01

Overall Team Climate with Age

H01: There is no significant difference in the mean value of team climate vis-à-vis age in software development teams.

The hypothesis H01 is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for overall team climate with age as factor are as shown in the following Table 5.22.

Table 5.22: Team climate vis-à-vis age – ANOVA results

Age	N	Mean	Std. Deviation	F	Sig.	Remarks
<25	138	3.828	0.511	0.374	0.689	**Supported**
26-35	34	3.843	0.480			
36-45	6	4.009	0.411			
Total	178	3.837	0.501			

The Significant value (0.689) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team climate vis-à-vis age. Thus the null hypothesis H01 is supported. That means **there is no significant difference in the mean value of team climate vs. age in software development teams.**

Vision with Age

H01(a): There is no significant difference in the mean value of *vision* as a dimension of team climate vis-à-vis age in software development teams

The hypothesis H01(a) is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for *vision* with age as factor are as shown in the following Table 5.23.

Table 5.23: Vision vis-à-vis age – ANOVA results

Age	N	Mean	Std. Deviation	F	Sig.	Remarks
<25	138	3.754	0.540	0.577	0.563	Supported
26-35	34	3.773	0.421			
36-45	6	3.985	0.447			
Total	178	3.766	0.515			

The Significant value (0.563) is greater than 0.05, indicates that there is no significant difference exists in the mean value of *vision* vis-à-vis age. Thus the null hypothesis H01(a) is supported. That means **there is no significant difference in the mean value of *vision* as a dimension of team climate vs. age in software development teams.**

Task Orientation with Age

H01(b): There is no significant difference in the mean value of task orientation as a dimension of team climate vis-à-vis age in software development teams

The hypothesis H01(b) is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for *task orientation* with age as factor are as shown in the following Table 5.24.

Table 5.24: Task orientation vis-à-vis age– ANOVA results

Age	N	Mean	Std. Deviation	F	Sig.	Remarks
<25	138	3.870	0.596	0.217	0.805	Supported
26-35	34	3.832	0.570			
36-45	6	4.000	0.361			
Total	178	3.867	0.583			

The Significant value (0.805) is greater than 0.05, indicates that there is no significant difference exists in the mean value of task orientation vis-à-vis age. Thus the null hypothesis H01(b) is supported. That means **there is no significant difference in the mean value of *task orientation* as a dimension of team climate vs. age in software development teams.**

Support for Innovation with Age

H01(c): There is no significant difference in the mean value of *support for innovation* as a dimension of team climate vis-à-vis age in software development teams

The hypothesis H01(c) is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for *support for innovation* with age as factor are as shown in the following Table 5.25.

Table 5.25: Support for innovation vis-à-vis age – ANOVA results

Age	N	Mean	Std. Deviation	F	Sig.	Remarks
<25	138	3.839	0.726	0.364	0.696	Supported
26-35	34	3.820	0.681			
36-45	6	4.083	0.438			
Total	178	3.843	0.708			

The Significant value (0.696) is greater than 0.05, indicates that there is no significant difference exists in the mean value of support for innovation vis-à-vis age. Thus the null hypothesis H01(c) is supported. That means **there is no significant difference in the mean value of *support for innovation* as a dimension of team climate vs. age in software development teams.**

Participative Safety with Age

H01(d): There is no significant difference in the mean value of *participative safety* as a dimension of team climate vis-à-vis age in software development teams

The hypothesis H01(d) is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for *participative safety* with age as factor are as shown in the following Table 5.26.

Table 5.26: Participative safety vis-à-vis age – ANOVA results

Age	N	Mean	Std. Deviation	F	Sig.	Remarks
<25	138	3.865	0.637	0.225	0.799	Supported
26-35	34	3.929	0.631			
36-45	6	3.986	0.602			
Total	178	3.881	0.632			

The Significant value (0.799) is greater than 0.05, indicates that there is no significant difference exists in the mean value of participative safety vis-à-vis age. Thus the null hypothesis H01(d) is supported. That means **there is no significant difference in the mean value of *participative safety* as a dimension of team climate vs. age in software development teams.**

b) Team Productivity, Team Performance and Team Innovation with Age

Team Productivity with Age

H02: There is no significant difference in the mean value of team productivity vis-à-vis age in software development teams

The hypothesis H02 is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for *team productivity* with age as factor are as shown in the following Table 5.27.

Table 5.27: Team productivity vis-à-vis age – ANOVA results

Age	N	Mean	Std. Deviation	F	Sig.	Remarks
<25	138	3.550	0.369	1.601	0.205	**Supported**
26-35	34	3.671	0.516			
36-45	6	3.423	0.501			
Total	178	3.571	0.406			

The Significant value (0.205) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team productivity vis-à-vis age. Thus the null hypothesis H02 is supported. That means **there is no significant difference in the mean value of team productivity vs. age in software development teams.**

Team Performance with Age

H03: There is no significant difference in the mean value of team performance vis-à-vis age in software development teams

The hypothesis H03 is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for *team performance* with age as factor are as shown in the following Table 5.28.

Table 5.28: Team performance vis-à-vis age – ANOVA results

Age	N	Mean	Std. Deviation	F	Sig.	Remarks
<25	138	3.686	0.514	0.999	0.370	**Supported**
26-35	34	3.738	0.600			
36-45	6	3.983	0.223			
Total	178	3.706	0.525			

The Significant value (0.370) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team performance vis-à-vis age. Thus the null hypothesis H03 is supported. That means **there is no significant difference in the mean value of team performance vs. age in software development teams**.

Team Innovation with Age

H04: There is no significant difference in the mean value of team innovation vis-à-vis age in software development teams

The hypothesis H04 is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for *team innovation* with age as factor are as shown in the following Table 5.29.

Table 5.29: Team innovation vis-à-vis age – ANOVA results

Age	N	Mean	Std. Deviation	F	Sig.	Remarks
<25	138	3.453	0.535	1.307	0.273	Supported
26-35	34	3.625	0.678			
36-45	6	3.583	0.817			
Total	178	3.490	0.575			

The Significant value (0.273) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team innovation vis-à-vis age. Thus the null hypothesis H04 is supported. That means **there is no significant difference in the mean value of team innovation vs. age in software development teams**.

c) Team Climate with Gender

Overall Team Climate with Gender

H05: There is no significant difference in the mean value of team climate vis-à-vis gender in software development teams

The hypothesis H05 is tested using t-test technique and the interpretation is based on the t-stat and Significant value. The t-test results for overall *team climate* with gender as factor are as shown in the following Table 5.30.

Table 5.30: Team Climate vis-à-vis gender: t-test results

Gender	N	Mean	Std. Deviation	t-stat	Sig.	Remarks
MALE	114	3.777	0.494	-2.175	0.951	Supported
FEMALE	64	3.945	0.499			

The Significant value (0.951) is greater than 0.05, indicates that there is no significant difference exists in the mean value of overall team climate vis-à-vis gender. Thus the null hypothesis H05 is supported. That means **there is no significant difference in the mean value of team climate vs. gender in software development teams.**

Vision with Gender

H05(a): There is no significant difference in the mean value of *vision* as a dimension of team climate vis-à-vis gender in software development teams

The hypothesis H05(a) is tested using t-test technique and the interpretation is based on the t-stat and Significant value. The t-test results for *vision* as a dimension of team climate with gender as factor are as shown in the following Table 5.31.

Table 5.31: Vision vis-à-vis gender: t-test results

Gender	N	Mean	Std. Deviation	t-stat	Sig.	Remarks
MALE	114	3.735	0.525	-1.048	0.797	Supported
FEMALE	64	3.820	0.497			

The Significant value (0.797) is greater than 0.05, indicates that there is no significant difference exists in the mean value of vision vis-à-vis gender. Thus the null hypothesis H05(a) is supported. That means **there is no significant difference in the mean value**

of *vision* as a dimension of team climate vs. gender in software development teams.

Task Orientation with Gender

H05(b): There is no significant difference in the mean value of *task orientation* as a dimension of team climate vis-à-vis gender in software development teams

The hypothesis H05(b) is tested using t-test technique and the interpretation is based on the t-stat and Significant value. The t-test results for *task orientation* with gender as factor are as shown in the following Table 5.32.

Table 5.32: Task Orientation vis-à-vis gender: t-test results

	Gender	N	Mean	Std. Deviation	t-stat	Sig.	Remarks
Task Orientation	MALE	114	3.790	0.608	-2.392	0.158	**Supported**
	FEMALE	64	4.005	0.513			

The Significant value (0.158) is greater than 0.05, indicates that there is no significant difference exists in the mean value of task orientation vis-à-vis gender. Thus the null hypothesis H05(b) is supported. That means **there is no significant difference in the mean value of *task orientation* as a dimension of team climate vs. gender in software development teams.**

Support for Innovation with Gender

H05(c): There is no significant difference in the mean value of *support for innovation* as a dimension of team climate vis-à-vis gender in software development teams

The hypothesis H05(c) is tested using t-test technique and the interpretation is based on the t-stat and Significant value. The t-test results for support for innovation as a dimension of team climate with gender as factor are as shown in the following Table 5.33.

Table 5.33: Support for Innovation vis-à-vis gender: t-test results

	Gender	N	Mean	Std. Deviation	t-stat	Sig.	Remarks
Support for Innovation	MALE	114	3.783	0.691	-1.527	0.588	**Supported**
	FEMALE	64	3.951	0.730			

The Significant value (0.588) is greater than 0.05, indicates that there is no significant difference exists in the mean value of support for innovation vis-à-vis gender. Thus the null hypothesis H05(c) is supported. That means **there is no significant difference in the mean value of support for innovation as a dimension of team climate vs. gender in software development teams.**

Participative Safety with Gender

H05(d): There is no significant difference in the mean value of *participative safety* as a dimension of team climate vis-à-vis gender in software development teams

The hypothesis H05(d) is tested using t-test technique and the interpretation is based on the t-stat and Significant value. The t-test results for participative safety as a dimension of team climate with gender as factor are as shown in the following Table 5.34.

Table 5.34: Participative Safety vis-à-vis gender: t-test results

	Gender	N	Mean	Std. Deviation	t-stat	Sig.	Remarks
Participative Safety	MALE	114	3.803	0.658	-2.236	0.202	**Supported**
	FEMALE	64	4.021	0.560			

The Significant value (0.202) is greater than 0.05, indicates that there is no significant difference exists in the mean value of participative safety vis-à-vis gender. Thus the null hypothesis H05(d) is supported. That means **there is no significant difference in the mean value of participative safety as a dimension of team climate vs. gender in software development teams.**

d) Team Productivity, Team Performance and Team Innovation with Gender

Team Productivity with Gender

H06: There is no significant difference in the mean value of team productivity vis-à-vis gender in software development teams

The hypothesis H06 is tested using t-test technique and the interpretation is based on the t-stat and Significant value. The t-test results for team productivity with gender as factor are as shown in the following Table 5.35.

Table 5.35: Team Productivity vis-à-vis gender: t-test results

	Gender	N	Mean	Std. Deviation	t-stat	Sig.	Remarks
Team Productivity	MALE	114	3.590	0.404	1.026	0.628	**Supported**
	FEMALE	64	3.530	0.411			

The Significant value (0.628) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team productivity vis-à-vis gender. Thus the null hypothesis H06 is supported. That means **there is no significant difference in the mean value of team productivity vs. gender in software development teams**.

Team Performance with Gender

H07: There is no significant difference in the mean value of team performance vis-à-vis gender in software development teams

The hypothesis H07 is tested using t-test technique and the interpretation is based on the t-stat and Significant value. The t-test results for team performance with gender as factor are as shown in the following Table 5.36.

Table 5.36: Team Performance vis-à-vis gender: t-test results

	Gender	N	Mean	Std. Deviation	t-stat	Sig.	Remarks
Team Performance	MALE	114	3.681	0.552	-0.863	0.213	**Supported**
	FEMALE	64	3.752	0.475			

The Significant value (0.213) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team performance vis-à-vis gender. Thus the null hypothesis H07 is supported. That means **there is no significant difference in the mean value of team performance vs. gender in software development teams.**

Team Innovation with Gender

H08: There is no significant difference in the mean value of team innovation vis-à-vis gender in software development teams

The hypothesis H08 is tested using t-test technique and the interpretation is based on the t-stat and Significant value. The t-test results for team innovation with gender as factor are as shown in the following Table 5.37.

Table 5.37: Team Innovation vis-à-vis gender: t-test results

	Gender	N	Mean	Std. Deviation	t-stat	Sig.	Remarks
Team Innovation	MALE	114	3.531	0.578	1.257	0.608	**Supported**
	FEMALE	64	3.418	0.567			

The Significant value (0.608) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team innovation vis-à-vis gender. Thus the null hypothesis H08 is supported. That means **there is no significant difference in the mean value of team innovation vs. gender in software development teams.**

e) Team Climate with Educational Qualifications

Overall Team Climate with Educational Qualifications

H09: There is no significant difference in the mean value of team climate vis-à-vis educational qualifications in software development teams

The hypothesis H09 is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for overall team climate with educational qualifications as factor are as shown in the following Table 5.38.

Table 5.38: Team Climate vis-à-vis Educational Qualifications – ANOVA results

Educational Qualifications	N	Mean	Std. Deviation	F	Sig.	Remarks
DIPLOMA/+2	2	4.158	0.074	0.428	0.652	**Supported**
BACHELORS	131	3.829	0.512			
PG AND ABOVE	45	3.845	0.478			
Total	178	3.837	0.501			

The Significant value (0.652) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team climate vis-à-vis educational qualifications. Thus the null hypothesis H09 is supported. That means **there is no significant difference in the mean value of team climate vs. educational qualifications in software development teams.**

Vision with Educational Qualifications

H09(a): There is no significant difference in the mean value of *vision* as a dimension of team climate vis-à-vis educational qualifications in software development teams

The hypothesis H09(a) is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for vision as a dimension of team climate with educational qualifications as factor are as shown in the following Table 5.39.

Table 5.39: Vision vis-à-vis Educational Qualifications – ANOVA results

Educational Qualifications	N	Mean	Std. Deviation	F	Sig.	Remarks
DIPLOMA/+2	2	4.091	0.129	0.401	0.671	**Supported**
BACHELORS	131	3.761	0.519			
PG AND ABOVE	45	3.764	0.516			
Total	178	3.766	0.515			

The Significant value (0.671) is greater than 0.05, indicates that there is no significant difference exists in the mean value of vision vis-à-vis educational qualifications. Thus the null hypothesis H09(a) is supported. That means **there is no significant difference in the mean value of vision as a dimension of team climate vs. educational qualifications in software development teams.**

Task Orientation with Educational Qualifications

H09(b): There is no significant difference in the mean value of *task orientation* as a dimension of team climate vis-à-vis educational qualifications in software development teams

The hypothesis H09(b) is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for task orientation as a dimension of team climate with educational qualifications as factor are as shown in the following Table 5.40.

Table 5.40: Task Orientation vis-à-vis Educational Qualifications – ANOVA results

Educational Qualifications	N	Mean	Std. Deviation	F	Sig.	Remarks
DIPLOMA/+2	2	4.214	0.303	1.451	0.237	Supported
BACHELORS	131	3.901	0.592			
PG AND ABOVE	45	3.752	0.555			
Total	178	3.867	0.583			

The Significant value (0.237) is greater than 0.05, indicates that there is no significant difference exists in the mean value of task orientation vis-à-vis educational qualifications. Thus the null hypothesis H09(b) is supported. That means **there is no significant difference in the mean value of task orientation as a dimension of team climate vs. educational qualifications in software development teams**.

Support for Innovation with Educational Qualifications

H09(c): There is no significant difference in the mean value of *support for innovation* as a dimension of team climate vis-à-vis educational qualifications in software development teams

The hypothesis H09(c) is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for *support for innovation* as a dimension of team climate with educational qualifications as factor are as shown in the following Table 5.41.

Table 5.41: Support for Innovation vis-à-vis Educational Qualifications – ANOVA results

Educational Qualifications	N	Mean	Std. Deviation	F	Sig.	Remarks
DIPLOMA/+2	2	4.313	0.442	0.597	0.552	Supported
BACHELORS	131	3.821	0.745			
PG AND ABOVE	45	3.889	0.598			
Total	178	3.843	0.708			

The Significant value (0.552) is greater than 0.05, indicates that there is no significant difference exists in the mean value of support for innovation vis-à-vis educational qualifications. Thus the null hypothesis H09(c) is supported. That means **there is no significant difference in the mean value of support for innovation as a dimension of team climate vs. educational qualifications in software development teams**.

Participative Safety with Educational Qualifications

H09(d): There is no significant difference in the mean value of *participative safety* as a dimension of team climate vis-à-vis educational qualifications in software development teams

The hypothesis H09(d) is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for *participative safety* as a dimension of team climate with educational qualifications as factor are as shown in the following Table 5.42.

Table 5.42: Participative Safety vis-à-vis Educational Qualifications – ANOVA results

Educational Qualifications	N	Mean	Std. Deviation	F	Sig.	Remarks
DIPLOMA/+2	2	4.083	0.236	0.427	0.653	Supported
BACHELORS	131	3.856	0.650			
PG AND ABOVE	45	3.944	0.590			
Total	178	3.881	0.632			

The Significant value (0.653) is greater than 0.05, indicates that there is no significant difference exists in the mean value of participative safety vis-à-vis educational qualifications. Thus the null hypothesis H09(d) is supported. That means **there is no significant difference in the mean value of participative safety as a dimension of team climate vs. educational qualifications in software development teams**.

f) Team Productivity, Team Performance and Team Innovation with Educational Qualifications

Team Productivity with Educational Qualifications

H10: There is no significant difference in the mean value of team productivity vis-à-vis educational qualifications in software development teams

The hypothesis H10 is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for team productivity with educational qualifications as factor are as shown in the following Table 5.43.

Table 5.43: Team Productivity vis-à-vis Educational Qualifications – ANOVA results

Educational Qualifications	N	Mean	Std. Deviation	F	Sig.	Remarks
DIPLOMA/+2	2	3.83	0.247	0.443	0.643	Supported
BACHELORS	131	3.57	0.384			
PG AND ABOVE	45	3.55	0.474			
Total	178	3.57	0.406			

The Significant value (0.643) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team productivity vis-à-vis educational qualifications. Thus the null hypothesis H10 is supported. That means **there is no significant difference in the mean value of team productivity vs. educational qualifications in software development teams**.

Team Performance with Educational Qualifications

H11: There is no significant difference in the mean value of team performance vis-à-vis educational qualifications in software development teams

The hypothesis H11 is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for team performance with educational qualifications as factor are as shown in the following Table 5.44.

Table 5.44: Team Performance vis-à-vis Educational Qualifications – ANOVA results

Educational Qualifications	N	Mean	Std. Deviation	F	Sig.	Remarks
DIPLOMA/+2	2	4.250	0.354	1.488	0.229	Supported
BACHELORS	131	3.679	0.542			
PG AND ABOVE	45	3.760	0.469			
Total	178	3.706	0.525			

The Significant value (0.229) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team performance vis-à-vis educational qualifications. Thus the null hypothesis H11 is supported. That means **there is no significant difference in the mean value of team performance vs. educational qualifications in software development teams**.

Team Innovation with Educational Qualifications

H12: There is no significant difference in the mean value of team innovation vis-à-vis educational qualifications in software development teams

The hypothesis H12 is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for team innovation with educational qualifications as factor are as shown in the following Table 5.45.

Table 5.45: Team Innovation vis-à-vis Educational Qualifications – ANOVA results

Educational Qualifications	N	Mean	Std. Deviation	F	Sig.	Remarks
DIPLOMA/+2	2	3.875	0.177	1.137	0.323	Supported
BACHELORS	131	3.456	0.550			
PG AND ABOVE	45	3.572	0.648			
Total	178	3.490	0.575			

The Significant value (0.323) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team innovation vis-à-vis educational qualifications. Thus the null hypothesis H12 is supported. That means **there is no significant difference in the mean value of team innovation vs. educational qualifications in software development teams**.

g) Team Climate with Experience

Overall Team Climate with Experience

H13: There is no significant difference in the mean value of team climate vis-à-vis experience in software development teams

The hypothesis H13 is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for overall team climate with experience as factor are as shown in the following Table 5.46.

Table 5.46: Team Climate vis-à-vis Experience – ANOVA results

Experience (in Years)	N	Mean	Std. Deviation	F	Sig.	Remarks
<5	146	3.816	0.514	0.543	0.654	Supported
5-10	26	3.914	0.444			
11-15	5	3.984	0.455			
>15	1	4.132	.			
Total	178	3.837	0.501			

The Significant value (0.654) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team climate vis-à-vis experience. Thus the null hypothesis H13 is supported. That means **there is no significant difference in the mean value of team climate vs. experience in software development teams**.

Vision with Experience

H13(a): There is no significant difference in the mean value of *vision* as a dimension of team climate vis-à-vis experience in software development teams

The hypothesis H13(a) is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for vision as a dimension of team climate with experience as factor are as shown in the following Table 5.47.

Table 5.47: Vision vis-à-vis Experience – ANOVA results

Experience (in Years)	N	Mean	Std. Deviation	F	Sig.	Remarks
<5	146	3.754	0.532	0.447	0.720	Supported
5-10	26	3.780	0.435			
11-15	5	3.946	0.488			
>15	1	4.182	.			
Total	178	3.766	0.515			

The Significant value (0.720) is greater than 0.05, indicates that there is no significant difference exists in the mean value of vision vis-à-vis experience. Thus the null hypothesis H13(a) is supported. That means **there is no significant difference in the mean value of vision as a dimension of team climate vs. experience in software development teams.**

Task Orientation with Experience

H13(b): There is no significant difference in the mean value of *task orientation* as a dimension of team climate vis-à-vis experience in software development teams

The hypothesis H13(b) is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for task orientation as a dimension of team climate with experience as factor are as shown in the following Table 5.48.

Table 5.48: Task Orientation vis-à-vis Experience – ANOVA results

Experience (in Years)	N	Mean	Std. Deviation	F	Sig.	Remarks
<5	146	3.857	0.606	0.130	0.942	Supported
5-10	26	3.890	0.494			
11-15	5	4.000	0.405			
>15	1	4.000	.			
Total	178	3.867	0.583			

The Significant value (0.942) is greater than 0.05, indicates that there is no significant difference exists in the mean value of task orientation vis-à-vis experience. Thus the null hypothesis H13(b) is supported. That means **there is no significant difference in the mean value of task orientation as a dimension of team climate vs. experience in software development teams.**

Support for Innovation with Experience

H13(c): There is no significant difference in the mean value of *support for innovation* as a dimension of team climate vis-à-vis experience in software development teams

The hypothesis H13(c) is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for *support for innovation* as a dimension of team climate with experience as factor are as shown in the following Table 5.49.

Table 5.49: Support for Innovation vis-à-vis Experience – ANOVA results

Experience (in Years)	N	Mean	Std. Deviation	F	Sig.	Remarks
<5	146	3.824	0.729	0.340	0.797	Supported
5-10	26	3.894	0.640			
11-15	5	4.125	0.476			
>15	1	3.875	.			
Total	178	3.843	0.708			

The Significant value (0.797) is greater than 0.05, indicates that there is no significant difference exists in the mean value of support for innovation vis-à-vis experience. Thus the null hypothesis H13(c) is supported. That means **there is no significant difference in the mean value of support for innovation as a dimension of team climate vs. experience in software development teams.**

Participative Safety with Experience

H13(d): There is no significant difference in the mean value of *participative safety* as a dimension of team climate vis-à-vis experience in software development teams

The hypothesis H13(d) is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for *participative safety* as a dimension of team climate with experience as factor are as shown in the following Table 5.50.

Table 5.50: Participative Safety vis-à-vis Experience – ANOVA results

Experience (in Years)	N	Mean	Std. Deviation	F	Sig.	Remarks
<5	146	3.844	0.649	1.071	0.363	Supported
5-10	26	4.064	0.516			
11-15	5	3.917	0.646			
>15	1	4.333	.			
Total	178	3.881	0.632			

The Significant value (0.363) is greater than 0.05, indicates that there is no significant difference exists in the mean value of participative safety vis-à-vis experience. Thus the null hypothesis H13(d) is supported. That means **there is no significant difference in the mean value of participative safety as a dimension of team climate vs. experience in software development teams.**

h) Team Productivity, Team Performance and Team Innovation with Experience

Team Productivity with Experience

H14: There is no significant difference in the mean value of team productivity vis-à-vis experience in software development teams

The hypothesis H14 is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for team productivity with experience as factor are as shown in the following Table 5.51.

Table 5.51: Team Productivity vis-à-vis Experience – ANOVA results

Experience (in Years)	N	Mean	Std. Deviation	F	Sig.	Remarks
<5	146	3.58	0.392	0.299	0.826	Supported
5-10	26	3.57	0.471			
11-15	5	3.41	0.559			
>15	1	3.45	.			
Total	178	3.57	0.406			

The Significant value (0.826) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team productivity vis-à-vis experience. Thus the null hypothesis H14 is supported. That means **there is no significant difference in the mean value of team productivity vs. experience in software development teams**.

Team Performance with Experience

H15: There is no significant difference in the mean value of team performance vis-à-vis experience in software development teams

The hypothesis H15 is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for team performance with experience as factor are as shown in the following Table 5.52.

Table 5.52: Team Performance vis-à-vis Experience – ANOVA results

Experience (in Years)	N	Mean	Std. Deviation	F	Sig.	Remarks
<5	146	3.699	0.515	0.582	0.628	Supported
5-10	26	3.681	0.621			
11-15	5	3.980	0.249			
>15	1	4.000	.			
Total	178	3.706	0.525			

The Significant value (0.628) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team performance vis-à-vis experience. Thus the null hypothesis H15 is supported. That means **there is no significant difference in the mean value of team performance vs. experience in software development teams**.

Team Innovation with Experience

H16: There is no significant difference in the mean value of team innovation vis-à-vis experience in software development teams

The hypothesis H16 is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for team innovation with experience as factor are as shown in the following Table 5.53.

Table 5.53: Team Innovation vis-à-vis Experience – ANOVA results

Experience (in Years)	N	Mean	Std. Deviation	F	Sig.	Remarks
<5	146	3.485	0.552	0.092	0.965	Supported
5-10	26	3.500	0.663			
11-15	5	3.550	0.908			
>15	1	3.750	.			
Total	178	3.490	0.575			

The Significant value (0.965) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team innovation vis-à-vis experience. Thus the null hypothesis H16 is supported. That means **there is no significant difference in the mean value of team innovation vs. experience in software development teams.**

5.4.2 Dimensions of Team Climate, Team Productivity, Team Performance and Team Innovation with Organizational variables (team role and team size)

i) Team Climate with Team Role

Overall Team Climate with Team Role

H17: There is no significant difference in the mean value of team climate vis-à-vis team role in software development teams

The hypothesis H17 is tested using t-test technique and the interpretation is based on the t-stat and Significant value. The t-test results for overall *team climate* with team role as factor are as shown in the following Table 5.54.

Table 5.54: Team Climate with Team Role: t-test results

Team Role	N	Mean	Std. Deviation	t-stat	Sig.	Remarks
TEAM MEMBER	160	3.816	0.514	-1.686	0.024*	**Not Supported**
TEAM MANAGER	18	4.025	0.309			

* Significant at 95% confidence level

The Significant value (0.024) is less than 0.05, indicates that there exists significant difference in the mean value of overall team climate vis-à-vis team role. Thus the null hypothesis H17 is not supported. That means **there is significant difference in the mean value of team climate vs. team role in software development teams**.

Vision with Team Role

H17(a): There is no significant difference in the mean value of *vision* as a dimension of team climate vis-à-vis team role in software development teams

The hypothesis H17(a) is tested using t-test technique and the interpretation is based on the t-stat and Significant value. The t-test results for *vision* as a dimension of team climate with team role as factor are as shown in the following Table 5.55.

Table 5.55: Vision with Team Role: t-test results

Team Role	N	Mean	Std. Deviation	t-stat	Sig.	Remarks
TEAM MEMBER	160	3.750	0.531	-1.204	0.007*	Not Supported
TEAM MANAGER	18	3.904	0.323			

* Significant at 95% confidence level

The Significant value (0.007) is less than 0.05, indicates that there exists significant difference in the mean value of vision vis-à-vis team role. Thus the null hypothesis H17(a) is not supported. That means **there is significant difference in the mean value of vision as a dimension of team climate vs. team role in software development teams**.

Task Orientation with Team Role

H17(b): There is no significant difference in the mean value of *task orientation* as a dimension of team climate vis-à-vis team role in software development teams

The hypothesis H17(b) is tested using t-test technique and the interpretation is based on the t-stat and Significant value. The t-test results for *task orientation* as a dimension of team climate with team role as factor are as shown in the following Table 5.56.

Table 5.56: Task Orientation with Team Role: t-test results

Team Role	N	Mean	Std. Deviation	t-stat	Sig.	Remarks
TEAM MEMBER	160	3.845	0.604	-1.515	0.003*	Not Supported
TEAM MANAGER	18	4.064	0.278			

* Significant at 95% confidence level

The Significant value (0.003) is less than 0.05, indicates that there exists significant difference in the mean value of task orientation vis-à-vis team role. Thus the null hypothesis H17(b) is not supported. That means **there is significant difference in the**

mean value of task orientation as a dimension of team climate vs. team role in software development teams.

Support for Innovation with Team Role

H17(c): There is no significant difference in the mean value of *support for innovation* as a dimension of team climate vis-à-vis team role in software development teams

The hypothesis H17(c) is tested using t-test technique and the interpretation is based on the t-stat and Significant value. The t-test results for *support for innovation* as a dimension of team climate with team role as factor are as shown in the following Table 5.57.

Table 5.57: Support for Innovation with Team Role: t-test results

Team Role	N	Mean	Std. Deviation	t-stat	Sig.	Remarks
TEAM MEMBER	160	3.831	0.727	-0.725	0.136	Supported
TEAM MANAGER	18	3.958	0.511			

The Significant value (0.136) is greater than 0.05, indicates that there is no significant difference exists in the mean value of support for innovation vis-à-vis team role. Thus the null hypothesis H17(c) is supported. That means **there is no significant difference in the mean value of support for innovation as a dimension of team climate vs. team role in software development teams.**

Participative Safety with Team Role

H17(d): There is no significant difference in the mean value of *participative safety* as a dimension of team climate vis-à-vis team role in software development teams

The hypothesis H17(d) is tested using t-test technique and the interpretation is based on the t-stat and Significant value. The t-test results for *participative safety* as a dimension of team climate with team role as factor are as shown in the following Table 5.58.

Table 5.58: Participative Safety with Team Role: t-test results

Team Role	N	Mean	Std. Deviation	t-stat	Sig.	Remarks
TEAM MEMBER	160	3.850	0.645	-1.973	0.065	**Supported**
TEAM MANAGER	18	4.157	0.412			

The Significant value (0.065) is greater than 0.05, indicates that there is no significant difference exists in the mean value of participative safety vis-à-vis team role. Thus the null hypothesis H17(d) is supported. That means **there is no significant difference in the mean value of *participative safety* as a dimension of team climate vs. team role in software development teams.**

j) Team Productivity, Team Performance and Team Innovation with Team Role

Team Productivity with Team Role

H18: There is no significant difference in the mean value of team productivity vis-à-vis team role in software development teams

The hypothesis H18 is tested using t-test technique and the interpretation is based on the t-stat and Significant value. The t-test results for team productivity with team role as factor are as shown in the following Table 5.59.

Table 5.59: Team Productivity with Team Role: t-test results

Team Role	N	Mean	Std. Deviation	t-stat	Sig.	Remarks
TEAM MEMBER	160	3.57	0.402	-0.041	0.529	**Supported**
TEAM MANAGER	18	3.57	0.457			

The Significant value (0.529) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team productivity vis-à-vis team role. Thus the null hypothesis H18 is supported. That means **there is no significant difference in the mean value of team productivity vs. team role in software development teams.**

Team Performance with Team Role

H19: There is no significant difference in the mean value of team performance vis-à-vis team role in software development teams

The hypothesis H19 is tested using t-test technique and the interpretation is based on the t-stat and Significant value. The t-test results for team performance with team role as factor are as shown in the following Table 5.60.

Table 5.60: Team Performance with Team Role: t-test results

Team Role	N	Mean	Std. Deviation	t-stat	Sig.	Remarks
TEAM MEMBER	160	3.694	0.524	-0.941	0.778	**Supported**
TEAM MANAGER	18	3.817	0.536			

The Significant value (0.778) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team performance vis-à-vis team role. Thus the null hypothesis H19 is supported. That means **there is no significant difference in the mean value of team performance vs. team role in software development teams.**

Team Innovation with Team Role

H20: There is no significant difference in the mean value of team innovation vis-à-vis team role in software development teams

The hypothesis H20 is tested using t-test technique and the interpretation is based on the t-stat and Significant value. The t-test results for team innovation with team role as factor are as shown in the following Table 5.61.

Table 5.61: Team Innovation with Team Role: t-test results

Team Role	N	Mean	Std. Deviation	t-stat	Sig.	Remarks
TEAM MEMBER	160	3.488	0.570	-0.184	0.744	**Supported**
TEAM MANAGER	18	3.514	0.639			

The Significant value (0.744) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team innovation vis-à-vis team role. Thus the null hypothesis H20 is supported. That means **there is no significant difference in the mean value of team innovation vs. team role in software development teams.**

K) Team Climate with Team size

Overall Team Climate with Team Size

H21: There is no significant difference in the mean value of team climate vis-à-vis team size in software development teams

The hypothesis H21 is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for overall team climate with team size as factor are as shown in the following Table 5.62.

Table 5.62: Team Climate vis-à-vis team size - ANOVA results

Team Size	Total No. of Members N	Mean	Std. Deviation	F	Sig.	Remarks
2 to 4	5	3.716	0.486	2.295	0.080	**Supported**
5 to 9	44	3.851	0.503			
10 to 15	79	3.926	0.458			
> 16	50	3.697	0.544			
Total	178	3.837	0.501			

The Significant value (0.080) is greater than 0.05, indicates that there is no significant difference exists in the mean value of team climate vis-à-vis team size. Thus the null hypothesis H21 is supported. That means **there is no significant difference in the mean value of overall team climate vs. team size in software development teams**.

Vision with Team Size

H21(a): There is no significant difference in the mean value of *vision* as a dimension of team climate vis-à-vis team size in software development teams

The hypothesis H21(a) is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for *vision* as a dimension of team climate with team size as factor are as shown in the following Table 5.63.

Table 5.63: Vision vis-à-vis team size - ANOVA results

Team Size	Total No. of Members N	Mean	Std. Deviation	F	Sig.	Remarks
2 to 4	5	3.636	0.545	0.456	0.713	Supported
5 to 9	44	3.700	0.503			
10 to 15	79	3.795	0.536			
> 16	50	3.789	0.499			
Total	178	3.766	0.515			

The Significant value (0.713) is greater than 0.05, indicates that there is no significant difference exists in the mean value of vision vis-à-vis team size. Thus the null hypothesis H21(a) is supported. That means **there is no significant difference in the mean value of vision as a dimension of team climate vs. team size in software development teams**.

Task Orientation with Team Size

H21(b): There is no significant difference in the mean value of *task orientation* as a dimension of team climate vis-à-vis team size in software development teams

The hypothesis H21(b) is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for *task orientation* as a dimension of team climate with team size as factor are as shown in the following Table 5.64.

Table 5.64: Task Orientation vis-à-vis team size - ANOVA results

Team Size	Total No. of Members N	Mean	Std. Deviation	F	Sig.	Remarks
2 to 4	5	3.571	0.452	2.938	0.035*	Not Supported
5 to 9	44	3.955	0.532			
10 to 15	79	3.949	0.536			
> 16	50	3.689	0.669			
Total	178	3.867	0.583			

* Significant at 95% confidence level

The Significant value (0.035) is less than 0.05, indicates that there exists significant difference in the mean value of task orientation vis-à-vis team size. Thus the null hypothesis H21(b) is not supported. That means **there is significant difference in the mean value of task orientation as a dimension of team climate vs. team size in software development teams.**

Support for Innovation with Team Size

H21(c): There is no significant difference in the mean value of *support for innovation* as a dimension of team climate vis-à-vis team size in software development teams

The hypothesis H21(c) is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for *support for innovation* as a dimension of team climate with team size as factor are as shown in the following Table 5.65.

Table 5.65: Support for Innovation vis-à-vis team size - ANOVA results

Team Size	Total No. of Members N	Mean	Std. Deviation	F	Sig.	Remarks
2 to 4	5	4.025	0.463	3.332	0.021*	**Not Supported**
5 to 9	44	3.830	0.675			
10 to 15	79	3.992	0.608			
> 16	50	3.603	0.842			
Total	178	3.843	0.708			

* Significant at 95% confidence level

The Significant value (0.021) is less than 0.05, indicates that there exists significant difference in the mean value of support for innovation vis-à-vis team size. Thus the null hypothesis H21(c) is not supported. That means **there is significant difference in the mean value of support for innovation as a dimension of team climate vs. team size in software development teams.**

Participative Safety with Team Size

H21(d): There is no significant difference in the mean value of *participative safety* as a dimension of team climate vis-à-vis team size in software development teams

The hypothesis H21(d) is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for *participative safety* as a dimension of team climate with team size as factor are as shown in the following Table 5.66.

Table 5.66: Participative Safety vis-à-vis team size - ANOVA results

Team Size	Total No. of Members N	Mean	Std. Deviation	F	Sig.	Remarks
2 to 4	5	3.667	0.669	2.860	0.038*	**Not Supported**
5 to 9	44	3.941	0.632			
10 to 15	79	3.988	0.524			
> 16	50	3.680	0.742			
Total	178	3.881	0.632			

* Significant at 95% confidence level

The Significant value (0.038) is less than 0.05, indicates that there exists significant difference in the mean value of participative safety vis-à-vis team size. Thus the null hypothesis H21(d) is not supported. That means **there is significant difference in the mean value of participative safety as a dimension of team climate vs. team size in software development teams**.

l) Team Productivity, Team Performance and Team Innovation with Team Size

Team Productivity with Team Size

H22: There is no significant difference in the mean value of team productivity vis-à-vis team size in software development teams

The hypothesis H22 is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for team productivity with team size as factor are as shown in the following Table 5.67.

Table 5.67: Team Productivity vis-à-vis team size - ANOVA results

Team Size	Total No. of Members N	Mean	Std. Deviation	F	Sig.	Remarks
2 to 4	5	3.06	0.055	5.179	0.002*	Not Supported
5 to 9	44	3.58	0.430			
10 to 15	79	3.66	0.476			
> 16	50	3.47	0.155			
Total	178	3.57	0.406			

* Significant at 95% confidence level

The Significant value (0.002) is less than 0.05, indicates that there exists significant difference in the mean value of team productivity vis-à-vis team size. Thus the null hypothesis H22 is not supported. That means **there is significant difference in the mean value of team productivity vs. team size in software development teams**.

Team Performance with Team Size

H23: There is no significant difference in the mean value of team performance vis-à-vis team size in software development teams

The hypothesis H23 is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for team performance with team size as factor are as shown in the following Table 5.68.

Table 5.68: Team Performance vis-à-vis team size - ANOVA results

Team Size	Total No. of Members N	Mean	Std. Deviation	F	Sig.	Remarks
2 to 4	5	3.760	0.288	1.318	0.270	**Supported**
5 to 9	44	3.646	0.602			
10 to 15	79	3.790	0.490			
> 16	50	3.622	0.516			
Total	178	3.706	0.525			

The Significant value (0.270) is greater than 0.05, indicates that there is no significant difference in the mean value of team performance vis-à-vis team size. Thus the null hypothesis H23 is supported. That means **there is no significant difference in the mean value of team performance vs. team size in software development teams.**

Team Innovation with Team Size

H24: There is no significant difference in the mean value of team innovation vis-à-vis team size in software development teams

The hypothesis H24 is tested using ANOVA and the interpretation is based on the F and Significant value. The One way ANOVA results for team innovation with team size as factor are as shown in the following Table 5.69.

Table 5.69: Team Innovation vis-à-vis team size - ANOVA results

Team Size	Total No. of Members N	Mean	Std. Deviation	F	Sig.	Remarks
2 to 4	5	3.150	0.822	14.522	0.000*	**Not Supported**
5 to 9	44	3.409	0.489			
10 to 15	79	3.760	0.612			
> 16	50	3.170	0.309			
Total	178	3.490	0.575			

* Significant at 95% confidence level

The Significant value (0.000) is less than 0.05, indicates that there exists significant difference in the mean value of team innovation vis-à-vis team size. Thus the null hypothesis H24 is not supported. That means **there is significant difference in the mean value of team innovation vs. team size in software development teams.**

Summary of Null Hypotheses Supported/Not Supported

Following Table 5.70 gives the results of hypotheses testing for Hypotheses H01-H24.

Table 5.70: Summary of Null Hypotheses Supported/Not Supported

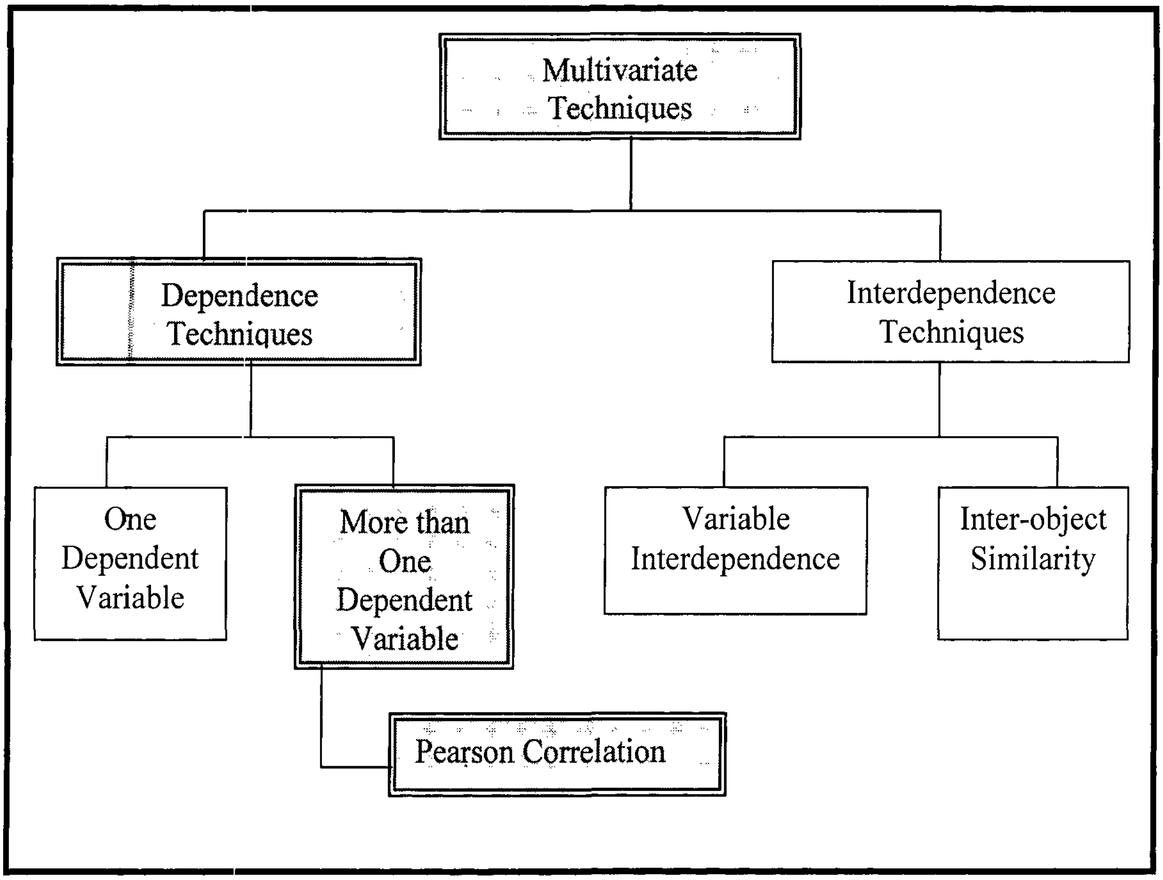
Demographic Variables	Hypothesis	Constructs	Results
Age	H01	Team Climate	Supported
	H01(a)	Vision	Supported
	H01(b)	Task Orientation	Supported
	H01(c)	Support for Innovation	Supported
	H01(d)	Participative Safety	Supported
	H02	Team Productivity	Supported
	H03	Team Performance	Supported
	H04	Team Innovation	Supported
Gender	H05	Team Climate	Supported
	H05(a)	Vision	Supported
	H05(b)	Task Orientation	Supported
	H05(c)	Support for Innovation	Supported
	H05(d)	Participative Safety	Supported
	H06	Team Productivity	Supported
	H07	Team Performance	Supported
	H08	Team Innovation	Supported
Educational Qualifications	H09	Team Climate	Supported
	H09(a)	Vision	Supported
	H09(b)	Task Orientation	Supported
	H09(c)	Support for Innovation	Supported
	H09(d)	Participative Safety	Supported
	H10	Team Productivity	Supported
	H11	Team Performance	Supported
	H12	Team Innovation	Supported
Experience	H13	Team Climate	Supported
	H13(a)	Vision	Supported
	H13(b)	Task Orientation	Supported
	H13(c)	Support for Innovation	Supported
	H13(d)	Participative Safety	Supported
	H14	Team Productivity	Supported
	H15	Team Performance	Supported
	H16	Team Innovation	Supported
Team Role	H17	Team Climate	Not Supported
	H17(a)	Vision	Not Supported
	H17(b)	Task Orientation	Not Supported
	H17(c)	Support for Innovation	Supported
	H17(d)	Participative Safety	Supported
	H18	Team Productivity	Supported
	H19	Team Performance	Supported
	H20	Team Innovation	Supported
Team Size	H21	Team Climate	Supported
	H21(a)	Vision	Supported
	H21(b)	Task Orientation	Not Supported
	H21(c)	Support for Innovation	Not Supported
	H21(d)	Participative Safety	Not Supported
	H22	Team Productivity	Not Supported
	H23	Team Performance	Supported
	H24	Team Innovation	Not Supported

5.5 Testing Relationships and Impact

The findings of this research basically gives whether there exists relationship and also impact between different components of team climate such as vision, task orientation, support for innovation, participative safety and team productivity, team performance and team innovation, team innovation and team productivity, team innovation and team performance. The current research also finds the impact of team climate on team productivity, team performance and team innovation, team productivity impact on team performance, team innovation impact on team productivity and team innovation impact on team performance as well. If the relationship exists between two different variables, it also gives the intensity or strength of the relationship between the two variables in question. Basically Karl Pearson's correlation coefficient (r) is used to find the relationship between two different variables. 'r' value varies between -1.0 and +1.0.

When there are more than one dependent variable multivariate techniques are used to find the relationship between dependent and independent variables.

Figure 5.2: Multivariate Analysis techniques



(Source: Malhotra, N.K. (2007), *Marketing Research: An Applied Orientation*, Fifth Edition, Pearson Education, Inc.)

In this research study there are three dependent variables such as team productivity, team performance and team innovation and the independent variable team climate. The correlations among dependent variables and the components of independent variable team climate are tabulated in Table 5.71 and 5.72. The values of correlation coefficient (r) indicate whether there exists relationship between these variables.

Multivariate analysis techniques are used when there is more than one dependent variable in the research model. The Table 5.71 consists of multivariate analysis at group level and Table 5.72 consists of the multivariate analysis at the organization level.

Table 5.71: Multivariate Analysis (Group Level)

Team Climate Construct	**Team Productivity**		**Team Performance**		**Team Innovation**	
	Correlation Coefficient	Significance Level	Correlation Coefficient	Significance Level	Correlation Coefficient	Significance Level
Vision	0.511	0.000	0.844	0.000	-0.134	0.000
Task Orientation	0.548	0.000	-0.178	0.000	-0.855	0.000
Support for Innovation	0.104	0.000	0.508	0.000	0.911	0.000
Participative Safety	-0.046	0.000	0.542	0.000	0.584	0.000

(Source: Researcher Compiled)

Table 5.72: Multivariate Analysis (Organization Level)

Team Climate Construct	**Team Productivity**		**Team Performance**		**Team Innovation**	
	Correlation Coefficient	Significance Level	Correlation Coefficient	Significance Level	Correlation Coefficient	Significance Level
Vision	0.231	0.000	0.986	0.000	0.797	0.000
Task Orientation	0.155	0.000	0.833	0.000	0.882	0.000
Support for Innovation	0.015	0.000	0.939	0.000	0.858	0.000
Participative Safety	-0.232	0.000	0.947	0.000	0.804	0.000

(Source: Researcher Compiled)

5.5.1 Relationships among the Constructs/Dimensions of Team Climate, Team Productivity, Team Performance and Team Innovation

1. Relationship between Team Climate and Team Productivity

H25: There is no significant impact of team climate on team productivity in software development teams.

H25(a): There is no significant impact of *vision* as a dimension of team climate on team productivity in software development teams.

H25(b): There is no significant impact of *task orientation* as a dimension of team climate on team productivity in software development teams.

H25(c): There is no significant impact of *support for innovation* as a dimension of team climate on team productivity in software development teams.

H25(d): There is no significant impact of *participative safety* as a dimension of team climate on team productivity in software development teams.

The hypothesis tests the weight of impact of constructs of team climate such as *vision, task orientation, support for innovation* and *participative safety* on team productivity in software development teams. Following Table 5.73 gives the regression coefficients, t-Stat and p–value for the impact of team climate constructs on team productivity.

Table 5.73: Regression Table for Team Climate Impact on Team Productivity

Hypothesis Number	Team Climate Construct	Coefficients	Standard Error	t-Stat	P-value
H25(a)	Vision	0.143	0.473	0.302	0.767
H25(b)	Task Orientation	0.142	0.659	0.215	0.833
H25(c)	Support for Innovation	0.476	0.335	1.419	0.179
H25(d)	Participative Safety	0.827	0.560	1.476	0.164

(Source: Researcher)

The regression statistics are as follows

Multiple R	0.799
R Square	0.640
Adjusted R Square	0.529
Standard Error	0.314
Observations	18

R Square value (0.640) indicates the intensity of relationship between team climate and team productivity. The Critical tabulated value of t-Stat for n-2 (=16) degrees of freedom and $\alpha = 0.05$ is 1.7459 for a two tailed test (Appendix 4 of Malhotra (2007)). The calculated values of t-stat are less than the critical tabulated values of t (1.7459). Hence, all the null sub-hypotheses are supported. Following Table 5.74 gives the summary of supported or not supported of all the sub hypotheses.

Table 5.74: Supported or Not Supported the Null Hypothesis Team Climate impact on Team Productivity (H25)

Hypothesis Number	Team Climate Construct & Its Impact on Team Productivity	Supported/ Not Supported
H25(a)	Vision	Supported
H25(b)	Task Orientation	Supported
H25(c)	Support for Innovation	Supported
H25(d)	Participative Safety	Supported

(Source: Researcher)

That means, vision is not having an impact on team productivity, task orientation is not having an impact on team productivity, support for innovation is not having an impact on team productivity and participative safety is not having impact on team productivity in software development teams.

However the overall impact (regression) of independent variable team climate on team productivity is as shown in Table 5.75.

Table 5.75: Overall Team Climate Impact on Team Productivity

Hypothesis Number	Team Climate and	Coefficients	Standard Error	t-Stat	P-value
H25	Team Productivity	1.747	0.348	5.022	0.000

(Source: Researcher)

The regression statistics for the above relationships are as follows:

Multiple R	0.782
R Square	0.612
Adjusted R Square	0.588
Standard Error	0.294
Observations	18

The calculated value of t-stat (5.022) is greater than critical tabulated t-value (1.7459). This indicates that **overall team climate has an impact on team productivity**. The level of impact of team climate on team productivity is 0.612 (R square value). The individual constructs of team climate do not have an impact on team productivity separately.

2. Relationship between Team Climate and Team performance

H26: There is no significant impact of team climate on team performance in software development teams.

H26(a): There is no significant impact of *vision* as a dimension of team climate on team performance in software development teams.

H26(b): There is no significant impact of *task orientation* as a dimension of team climate on team performance in software development teams.

H26(c): There is no significant impact of *support for innovation* as a dimension of team climate on team performance in software development teams.

H26(d): There is no significant impact of *participative safety* as a dimension of team climate on team performance in software development teams.

The hypothesis tests the impact of team climate constructs *vision, task orientation, support for innovation* and *participative safety* on team performance. The following Table 5.76 gives the values of regression coefficients, standard error, t-stat and p-value for the impact of the team climate constructs on team performance.

Table 5.76: Regression Table for Team Climate Impact on Team Performance

Hypothesis Number	Team Climate Construct	Coefficients	Standard Error	t-Stat	P-value
H26(a)	Vision	0.371	0.187	1.984	0.069
H26(b)	Task Orientation	-0.354	0.261	-1.357	0.198
H26(c)	Support for Innovation	0.515	0.133	3.882	0.001
H26(d)	Participative Safety	0.323	0.222	1.457	0.169

(Source: Researcher)

The Critical tabulated value of t-Stat for n-2 (=16) degrees of freedom and $\alpha = 0.05$ is 1.7459 for a two tailed test (Appendix 4 of Malhotra (2007)). The calculated value of t-stat for sub-hypothesis H26(a) (1.984) is greater than the critical tabulated values of t (1.7459). Hence, the **null sub-hypothesis H26(a) is not supported**. The alternate hypothesis is the vision is having impact on the team performance in software development teams. The team climate level of impact can be measured using R square value (0.774) on team performance.

The regression statistics are as follows.

Multiple R	0.880
R Square	0.774
Adjusted R Square	0.704
Standard Error	0.124
Observations	18

The calculated value of t-stat for sub-hypothesis H26(b) (-1.357) is less than the critical tabulated t-value (1.7459). Hence **the null sub-hypothesis H26(b) is supported**. That means the task orientation is not having impact on team performance in software development teams. Similarly the calculated value of t-stat for sub-hypothesis H26(c) (3.882) is greater than critical tabulated t-value (1.7459). Hence, the **null sub-hypothesis H26(c) is not supported**. The alternate hypothesis is *support for innovation* is having impact on team performance in software development teams.

Similarly the calculated value of t-stat for sub-hypothesis H26(d) (1.457) is less than the tabulated value of t-stat (1.7459). Hence, **the null sub-hypothesis H26(d) is supported**. That means participative safety is not having impact on team performance in software development teams.

The sub-hypotheses supported or not supported for the impact of constructs of team climate on team performance is as shown in Table 5.77.

Table 5.77: Supported or Not Supported the Null Hypothesis Team Climate impact on Team Performance (H26)

Hypothesis Number	Team Climate Construct & Its Impact on Team Performance	Supported/ Not Supported
H26(a)	Vision	Not Supported
H26(b)	Task Orientation	Supported
H26(c)	Support for Innovation	Not Supported
H26(d)	Participative Safety	Supported

(Source: Researcher)

Overall team climate impact on team performance can be found from the following regression coefficients Table 5.78.

Table 5.78: Overall Team Climate Impact on Team Performance

Hypothesis Number	Team	Coefficients	Standard Error	t-Stat	P-value
H26	Climate & Team Performance	0.872	0.174	5.013	0.000

(Source: Researcher)

The regression statistics for the above relationship are as follows.

Multiple R	0.782
R Square	0.611
Adjusted R Square	0.587
Standard Error	0.147
Observations	18

The calculated t-value (5.013) is greater than the critical tabulated t-value (1.7459). This indicates that the **overall team climate is having an impact on team performance in software development teams**. The level of impact of team climate on team performance is 0.611 (R Square Value).

3. Relationship between Team Climate and Team Innovation:

H27: There is no significant impact of team climate on team innovation in software development teams.

H27(a): There is no significant impact of *vision* as a dimension of team climate on team innovation in software development teams.

H27(b): There is no significant impact of *task orientation* as a dimension of team climate on team innovation in software development teams.

H27(c): There is no significant impact of *support for innovation* as a dimension of team climate on team innovation in software development teams.

H27(d): There is no significant impact of *participative safety* as a dimension of team climate on team innovation in software development teams.

The research hypothesis tests the impact of team climate constructs such as *vision, task orientation, support for innovation* and *participative safety* on team innovation. The level of impact can be found from R square value and the hypothesis is proved using t-stat value. The following Table 5.79 gives the regression coefficients, standard error, t-stat and p-value for the impact of team climate constructs on team innovation.

Table 5.79: Regression Table for Team Climate Impact on Team Innovation

Hypothesis Number	Team Climate Construct	Coefficients	Standard Error	t-Stat	P-value
H27(a)	Vision	0.955	0.269	3.550	0.004
H27(b)	Task Orientation	-0.010	0.375	-0.027	0.979
H27(c)	Support for Innovation	0.963	0.191	5.051	0.000
H27(d)	Participative Safety	1.032	0.319	3.236	0.007

(Source: Researcher)

The calculated value of t-stat (3.550) for Hypothesis H27(a) is greater than the critical tabulated value of t (1.7459) for n-2 (=16) degrees of freedom and $\alpha = 0.05$ for a two tailed test (Appendix 4 of Malhotra (2007)). Hence, **the null sub-hypothesis H27(a) is not supported**. The alternate hypothesis is **vision is having an impact on team innovation in software development teams.**

Similarly, the calculated value of t-stat for Hypothesis H27(b) (-0.027) is less than the critical tabulated t-value (1.7459). Hence **the null hypothesis H27(b) is supported.**

That means the *task orientation* is not having an impact on team innovation in software development teams.

The calculated value of t-stat for the hypothesis H27(c) (5.051) is greater than the critical tabulated value of t (1.7459). Hence, the **null hypothesis H27(c) is not supported**. That means, **support for innovation is having an impact on team innovation in software development teams**.

Similarly, the calculated value of t-stat for the impact of participative safety on team innovation (3.236) is greater than critical tabulated value of t (1.7459). Hence, the **null hypothesis H27(d) is not supported**. This means that the **participative safety is having an impact on team innovation in software development teams**.

The regression statistics for the impact of team climate constructs and the team innovation are as follows.

Multiple R	0.970
R Square	0.940
Adjusted R Square	0.922
Standard Error	0.179
Observations	18

The intensity or impact of team climate on team innovation is 0.940 (R square value). The supported/not supported hypothesis results for the impact of team climate constructs on team innovation are as shown in the following Table 5.80.

Table 5.80: Supported or Not Supported the Null Hypothesis Team Climate impact on Team Innovation (H27)

Hypothesis Number	**Team Climate Construct & Its Impact on Team Innovation**	**Supported/ Not Supported**
H27(a)	Vision	Not Supported
H27(b)	Task Orientation	Supported
H27(c)	Support for Innovation	Not Supported
H27(d)	Participative Safety	Not Supported

(Source: Researcher)

Overall impact of team climate on team innovation can be found from the following regression Table 5.81.

Table 5.81: Overall Team Climate Impact on Team Innovation

Hypothesis Number	**Team Climate & Team Innovation**	**Coefficients**	**Standard Error**	**t-Stat**	**P-value**
H27		2.991	0.223	13.413	0.000

(Source: Researcher)

The regression statistics for overall team climate impact on team innovation are as follows.

Multiple R	0.958
R Square	0.918
Adjusted R Square	0.913
Standard Error	0.188
Observations	18

The calculated value of t-stat (13.413) is much greater than the critical tabulated value of t (1.7459). This indicates that the **team climate is having an impact on team innovation in software development teams**. The intensity of impact of team climate on team innovation in software development teams is major and it is evident from the R square value (0.918).

4. Relationship between Team Productivity and Team Performance:

H28: There is no significant impact of team productivity on team performance in software development teams.

The objective of the hypothesis is to test the impact of team productivity on team performance. This hypothesis is tested using the regression, standard error, t-stat value and the level of impact is measured using R square value. The regression coefficient, standard error, t-stat and p-value are tabulated in the following Table 5.82.

Table 5.82: Regression Table for Team productivity impact on Team Performance

Hypothesis Number	Team Productivity	Coefficients	Standard Error	t-Stat	P-value
H28	& Team Performance	0.398	0.075	5.281	0.000

(Source: Researcher)

The calculated value of t-stat (5.281) is greater than the critical tabulated value of t-stat (1.7459). Hence, **the null hypothesis H28 is not supported.** The alternate hypothesis is **team productivity is having significant impact on team performance in software development teams**.

The regression statistics for the impact of team productivity on team performance are as follows:

Multiple R	0.797
R Square	0.636
Adjusted R Square	0.613
Standard Error	0.142
Observations	18

The R Square value (0.636) indicates the level of impact of team productivity on team performance in software development teams.

5. Relationship between Team Innovation and Team Productivity:

H29: There is no significant impact of team innovation on team productivity in software development teams.

The hypothesis tests the impact of team innovation on team productivity in software development teams. This can be tested using regression and t-stat values. The regression coefficient, standards error, t-stat and p-value for the impact of team innovation on team productivity in software development teams are as shown in Table 5.83.

Table 5.83: Regression Table for Team Innovation impact on Team Productivity

Hypothesis Number	**Team Innovation & Team Productivity**	**Coefficients**	**Standard Error**	**t-Stat**	**P-value**
H29		0.620	0.089	6.930	0.000

(Source: Researcher)

The calculated value of t-stat (6.930) is greater than the critical tabulated value of t (1.7459) for n-2 (=16) degrees of freedom and $\alpha = 0.05$ for a two tailed test (Appendix 4 of Malhotra (2007)). Thus, **the null hypothesis H29 is not supported**. The alternate hypothesis is **team innovation has significant impact on team productivity in software development teams**.

The regression statistics for the impact of team innovation on team productivity are as follows:

Multiple R	0.866
R Square	0.750
Adjusted R Square	0.735
Standard Error	0.236
Observations	18

The value of R Square (0.750) indicates the level of impact of team innovation on team productivity in software development teams.

6. Relationship between Team Innovation and Team Performance:

H30: There is no significant impact of team innovation on team performance in software development teams.

The research hypothesis tests the impact of team innovation on team performance in software development teams. This can be tested using regression coefficient, t-stat and p-value calculated to find the impact of team innovation on team performance. These statistics are as shown in Table 5.84.

Table 5.84: Regression Table for Team Innovation impact on Team Performance

Hypothesis Number	**Team Innovation & Team Performance**	**Coefficients**	**Standard Error**	**t-Stat**	**P-value**
H30		0.301	0.048	6.227	0.000

(Source: Researcher)

The calculated value of t (6.227) is greater than the critical tabulated value of t (1.7459) for 16 degrees of freedom and $\alpha = 0.05$ for a two tailed test. This indicates that the **null hypothesis H30 is not supported**. The alternate hypothesis is **team innovation is having significant impact on team performance in software development teams**.

The regression statistics for the impact of team innovation on team performance are as follows:

Multiple R	0.841
R Square	0.708
Adjusted R Square	0.690
Standard Error	0.127
Observations	18

The R square value (0.708) indicates the value of impact of team innovation on team performance in software development teams. The regression statistics indicate that the team innovation is having more impact on team productivity (R Square = 0.750) than on the team performance (R Square = 0.708).

5.6 Path Analysis

To find out the relationships between different variables using Structured Equation Modeling, a software tool know as LISREL 8.5 is used. The correlations between different variables can be drawn pictorially using path diagrams in LISREL.

The objective of this path analysis is to build a structural equation model which will satisfy the conceptual model depicted in section 4.3. The conceptual model is made based on the already empirically proven four instruments. Based on this conceptual model the correlations between the latent variables are observed using the path diagrams. A structural equation model or the path diagram depicts the interaction between different latent variables (Kline, 1998).

A model is developed based on the constructs of team climate such as *vision, task orientation, support for innovation* and *participative safety* and the dependent variables such as team productivity, team performance and team innovation.

This section consists of the path diagrams for the relationship between team climate and productivity, performance and innovation in (Figure 5.3). The goodness of fit details for these models is in respective sub-section of this section.

The detailed SIMPLIS scripts used to draw the path diagrams shown in this section are given in Appendix -2.

The guidelines used to interpret the path diagrams are as follows. The statistical indexes used to analyze the path diagrams are degrees of freedom *(df)*, Chi-Square value *(Chi),* Root Mean Square Residual (RMR), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI) and Parsimony Goodness of Fix Index (PGFI). Usually no single measure can check the entire fitment of the model but a combination of measures can be used to check the fitment of a model with the data. Thus, the fitment of the model is done with combination of the statistical measures such as degrees of freedom *(df)*, Chi-Square value *(Chi),* RMR, GFI, AGFI and PGFI.

If the value of Chi-Square divided by degrees of freedom *(Chi/df)* is less than 3, the models can be treated as a good fit. According to Garson (2007), it is difficult to interpret the Root Mean Square Residual (RMR) value. However, Root Mean Square Residual (RMR) value less than 0.10 is a good measure. The RMR closure to zero is acceptable.

Goodness of Fit Index (GFI) values may be over estimating or may have problems associated with measures if the sample size is less than 200 (Garson, 2007). According to Garson (2007), GFI is no longer better measure of fitment but Adjusted Goodness of Fit Index (AGFI) is a good measure of fitment.

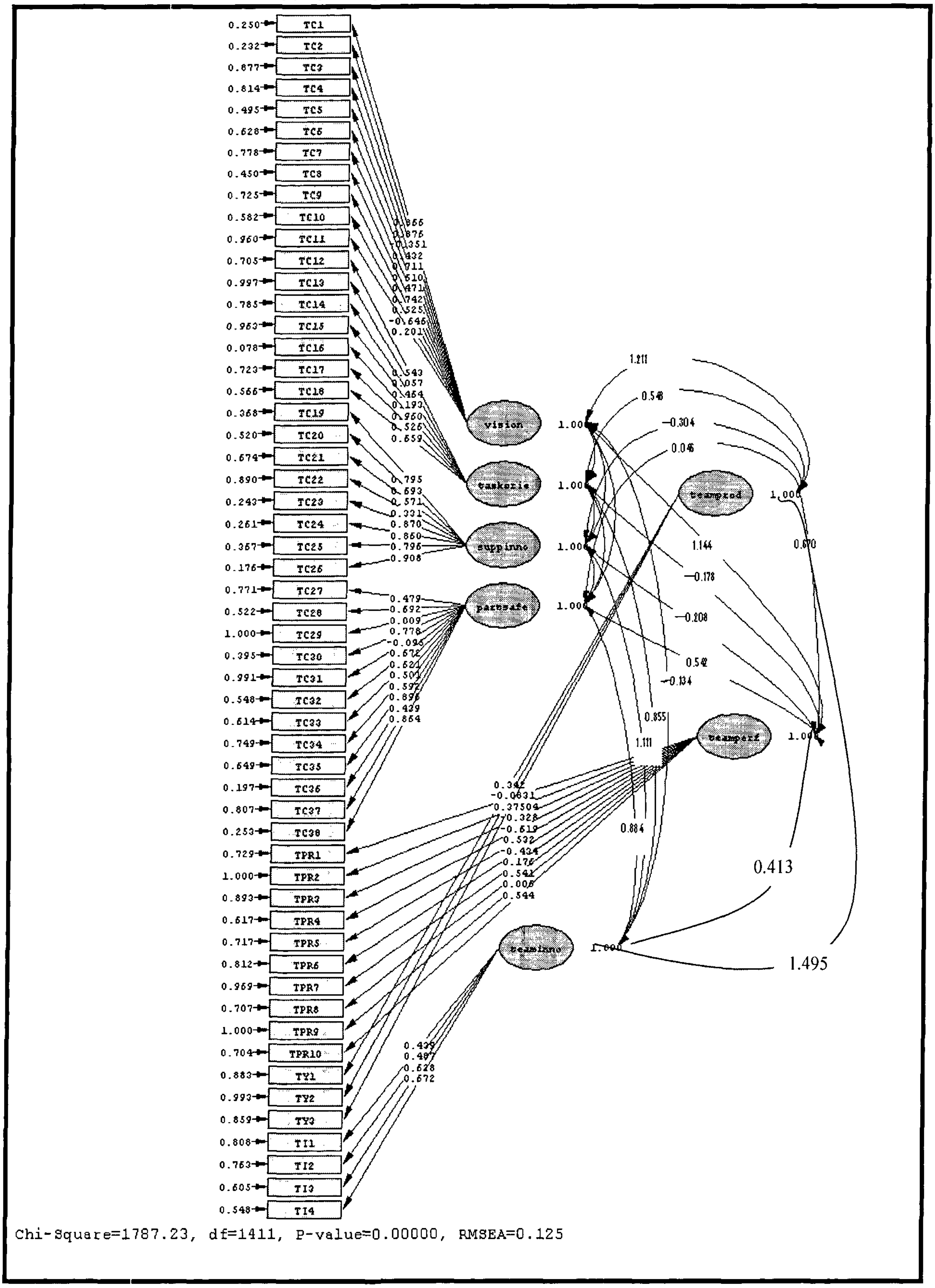
Adjusted Goodness of Fit (AGFI) index value greater than 1.0 is considered as good fit, less than 0.0 (zero) can be considered as bad fit, in between 0.0 and 1.0 is acceptable for the fitment (Garson, 2007). Higher Parsimony Goodness of Fit Index (PGFI) values are better for the fitment of the data.

The indexes such as Comparative Fit Index (CFI), Non-Normed Fit Index (NNFI) and Incremental Fit Index (IFI) are not considered because of the sample size less than 200. NNFI may not give best results for sample sizes less than 200. The above guidelines can be used to interpret the following path diagrams.

5.6.1 Path Analysis of Team Climate, Team Productivity, Team Performance, and Team Innovation

The path diagram with correlations for the entire model comprising constructs of team climate such as vision, task orientation, support for innovation and participative safety and team productivity, team performance and team innovation is as shown in Figure 5.3.

Figure 5.3: Path Diagram of Relationship between Team Climate and Team Productivity, Team Performance and Team Innovation



The correlation values and the relationships are expressed in the path diagram. From the path diagram it is evident that team innovation is moderately related (r = 0.413) with team performance and team innovation is strongly or perfectly related to team productivity because correlation coefficient (r = 1.495) is more than 1.0.

The goodness of fit details for this entire model is given in the Table 5.85.

Table 5.85: Goodness of Fit in relation to Team Climate, Team Productivity, Performance and Innovation

Sl. No.	Indices	Observed Value	Recommended Value
1.	Degrees of Freedom (*df*)	1411	
2.	Normal Theory Waited Least Squares Chi-Square (*Chi*)	1787.23	*(Chi/df)* < 3.0
3.	Root Mean Square Residual (RMR)	0.071	< 0.1 (Garson, 2007)
4.	Goodness of Fit Index (GFI)	0.21	>0.0 (Garson, 2007)
5.	Adjusted Goodness of Fit Index (AGFI)	0.13	0.0 to 1.0 (Garson, 2007)
6.	Parsimony Goodness of Fit Index (PGFI)	0.19	The maximum the better (Garson, 2007)

From the above statistics table, the value of *Chi-Square* (1787.23) divided by degrees of freedom (1411) is (*Chi/df* =1.267) less than 3.0. The value of Root Mean Square Residual (RMR = 0.071) is less than 0.1 and is closure to zero. The value of Adjusted Goodness of Fit Index (AGFI=0.13) is in between 0.0 and 1.0. Hence, the model fits with the data.

Thus the structured equation model developed satisfied the conceptual model given in section 4.3.

5.6.2 Interpretation of Structural Equation Modeling (SEM)

The SEM is used to investigate the impact of constructs of team climate such as *vision, task orientation, support for innovation* and *participative safety* on team productivity, team performance and team innovation. The interpretation (Table 5.86) is based on the path coefficients and significant values given by the path diagrams using LISREL 8.5.

Table 5.86: Summary of Null Hypotheses Supported/Not Supported using SEM

Sl. No.	Hypothesis Number	Relationship	Path Coefficient	t-value	Remarks
1	H25	Team Climate → Team Productivity	1.747	1.546	Not Supported
2	H25(a)	Vision → Team Productivity	1.211	1.324	Supported
3	H25(b)	Task Orientation → Team Productivity	0.548	1.077	Supported
4	H25(c)	Support for Innovation → Team Productivity	-0.304	-0.976	Supported
5	H25(d)	Participative Safety → Team Productivity	0.046	0.121	Supported
6	H26	Team Climate → Team Performance	0.872	0.979	Not Supported
7	H26(a)	Vision → Team Performance	1.144	14.785	Not Supported
8	H26(b)	Task Orientation → Team Performance	-0.178	-0.841	Supported
9	H26(c)	Support for Innovation → Team Performance	-0.208	-1.570	Not Supported
10	H26(d)	Participative Safety → Team Performance	0.548	3.390	Supported
11	H27	Team Climate → Team Innovation	2.991	21.764	Not Supported
12	H27(a)	Vision → Team Innovation	-0.134	-2.454	Not Supported
13	H27(b)	Task Orientation → Team Innovation	0.855	6.028	Supported
14	H27(c)	Support for Innovation → Team Innovation	1.111	11.224	Not Supported
15	H27(d)	Participative Safety → Team Innovation	0.884	6.966	Not Supported
16	H28	Team Productivity → Team Performance	0.670	0.957	Not Supported
17	H29	Team Innovation → Team Productivity	1.495	15.103	Not Supported
18	H30	Team Innovation → Team Performance	0.413	4.172	Not Supported

(Source: Researcher after SEM analysis)

This chapter consists of the explanation about the data preparation, steps involved in data analysis, proving hypothesis using Pearson correlation coefficients and multivariate analysis of multiple dependent variables. The structured equation modeling with path diagrams between different latent variables using LISREL are given and explained in this chapter.

Next Chapter consists of the conclusions such as answers to the research questions, summary of findings, contributions of this research study, limitations of current study and future directions for further research and final conclusion.

Chapter 6 : RESEARCH FINDINGS, CONCLUSION AND DIRECTIONS FOR FURTHER RESEARCH

Chapter 6: RESEARCH FINDINGS, CONCLUSION AND DIRECTIONS FOR FURTHER RESEARCH

The research findings, contributions of this work, recommendations to the Indian software industry, limitations of this research study, and the directions for further research are discussed in this chapter.

6.1 Research Findings

1. Team Climate with Demographic and Organizational Variables

Overall Team Climate

- From the current research, it is observed that there is **no significant difference** in the mean value of overall team climate along age, gender, educational qualifications, experience and team size.
- However it is observed that there is **significant difference** in the mean value of overall team climate along team roles such as team member or team manager.

Vision

- The research findings indicate that there is **no significant difference** in the mean value of *vision* as a dimension of team climate along age, gender, educational qualifications, experience and team size.
- However there is **significant difference** in the mean value of *vision* along organizational variable team role.

Task Orientation

- It is observed that there is **no significant difference** in the mean value of *task orientation* as a dimension of team climate against age, gender, educational qualifications and experience.
- Research findings indicate that there is **significant difference** in the mean value of *task orientation* as a dimension of team climate along organizational variables team role and team size.

Support for Innovation

- The research survey results indicate that there is **no significant difference** in the mean value of *support for innovation* as a dimension of team climate along age, gender, educational qualifications, experience and team role.
- It is also observed that there is **significant difference** in the mean value of *support for innovation* as a dimension of team climate along team size.

Participative Safety

- It is observed that there is **no significant difference** in the mean value of *participative safety* as a dimension of team climate along age, gender, educational qualifications, experience and team role.
- It is also observed that there is **significant difference** in the mean value of *participative safety* as a dimension of team climate along team size.

In a study done by Kumar (2011) on Ethiopian Banking sector, he observed the differences in team climate along some demographic variables. However he did not mention on what demographic variables he observed the differences in his publication. He expressed that he conducted F test on data. He conducted a research study to find out the factors affecting team climate. In current study some differences in team climate constructs are observed against organizational variables such as team role and team size. However, no differences in team climate are observed across demographic variables such as age, gender, education qualification and experience.

2. Team Productivity with Demographic and Organizational Variables

- Research findings exhibit that there is **no significant difference** in the mean value of team productivity along demographic variables such as age, gender, educational qualifications and experience and organizational variable team role.
- However it is observed that there is **significant difference** in the mean value of team productivity along team size.

Team size has been used in many studies (Smith, Hale and Parrish, 2001; Blackburn, Lapré and Van Wassenhove, 2002; Blackburn, Lapré and Van Wassenhove, 2002; Pendharkar and Rodger, 2007; Rodríguez, Sicilia, García and Harrison, 2011) related to software effort estimations and productivity. According to the research done by Pendharkar and Rodger (2007), the increase in team size increases the communication requirements and team expertise but results into no significant improvements in software effort.

In the current study, it is observed that for the teams having 10 to 15 members, the mean value of team productivity is much better than all other team sizes. For team size less than 10 and also for team size greater than 15 also the mean team productivity is less than the productivity of teams whose size is in between 10 and 15. Team size is resulting in differences in team productivity in the current research study.

According to the study of Rodríguez, Sicilia, García and Harrison (2011), team size and programming language used are correlated to team productivity. They observed that the teams having more than 9 people reported poor team productivity. Large teams have negative effect on software development team productivity (Smith, Hale and Parrish, 2001). This is true in current study also. Teams having more than 15 team members have exhibited poor team productivity.

According to Ramasubbu and Balan (2007), as team size increases the administration and coordination difficulties. In their two years field study they found that team size is negatively correlated to development productivity. Blackburn, Lapré and Van Wassenhove (2002) have conducted a study of 117 software projects in Finland and they found that maximum team size is negatively correlated with team productivity. This is also true in current study that maximum team sizes are resulting into reduced team productivity.

3. Team Performance with Demographic and Organizational Variables

- From the current research, it is observed that there is **no significant difference** in the mean value of team performance along age, gender, educational qualifications, experience, team role and team size.
- It is observed that no demographic or organizational variable considered for this current research resulting into significant difference in team performance.

In another study done by Stahl, Maznevski, Voigt and Jonsen, K. (2010), they found that cultural diversity is not directly related to team performance mediated by team size and team tenure; but team size has significant positive impact on team satisfaction and no significant impact on communication effectiveness on the way to team performance. In the current study also it is found that the demographic variables such as age, gender, educational qualifications, experience have no significant differences on team performance. Also it is observed that team size has no significant difference on team performance. Large teams do not necessarily result into higher team efficiency or team performance (Driskell and Salas, 2005; Shim and Srivastava, 2010). According to Driskell and Salas (2005), as team size increases the requirements for group coordination increases and complexity also increases.

Liang, Liu, Lin, and Lin (2007) have done an empirical study on software teams in Taiwan and found that knowledge diversity comprising education, major and department has impact on team performance mediated by task conflict and relationship conflict. They also found that social diversity comprising age, gender and income has mixed affects on software development team performance.

In a study of teams of students on a business strategy game done by Jenner, Zhao and Foote (2010), in collocated teams, team size is positively related to team performance up to 4 to 6 member teams and in virtual online teams, team size is not associated with team performance. In a study done by Partington and Harris (1999) on MBA student teams, it was observed that there is no significant relationship between team role balance and team performance. They used Belbin's team roles in their study. In a study of 33 teams done by Chong (2007), it was observed that the team role of coordinator is positively correlated with team performance. In the current study also there are significant differences in team climate against team role but not in team performance against team role.

Huckman, Staats and Upton (2009) have done a study on an Indian software services firm and found that team familiarity (number of years worked together with other team members in the team) and role experience (number of years in that specific role) are positively related to better team performance. However, team member's years of experience at the firm is not related to team performance in that specific study.

In a study of 130 German military teams by Huber, Eggenhofer, Römer, Schäfer and Titze (2007), it was found that age is negatively correlated with team performance and gender is weakly correlated with team performance because they are military teams.

4. Team Innovation with Demographic and Organizational Variables

- The research findings indicate that there is **no significant difference** in the mean value of team innovation against age, gender, educational qualifications, experience and team role.
- The results also indicate that there is **significant difference** in the mean value of team innovation along organizational variable team size.

It is observed that mean value of team innovation increased for team sizes from 2 till team size of 15; later it decreased. It indicates that the larger team sizes have less innovation and support for innovation. This is exactly matching with the research study of 87 cross industry Portuguese teams done by Curral, Forrester, Dawson and West (2001). They found that the larger teams result into lower support for innovation, lower level of team innovation, less clear objectives, lower level of participation and poorer team processes. In the current study also it is observed that for larger teams (team size > 15) support for innovation is having lower mean values to compare with smaller teams.

5. Relationship between Team Climate, Team Productivity, Team Performance and Team Innovation

The research findings of the relationships of team climate with team productivity, team performance and team innovation based on the correlation values are as shown in Table 6.1.

Table 0.1: Summary of Team Climate Relationships

Component of Team Climate	Team Productivity	Team Performance	Team Innovation
Vision	Moderate	Strong	No Relationship
Task Orientation	Moderate	No Relationship	No Relationship
Support for Innovation	Weak	Moderate	Strong
Participative Safety	No Relationship	Moderate	Moderate

(Source: Researcher)

1. **Relationship between team climate and team productivity in Software development teams**

Based on Table 6.1, overall **team climate is related to team productivity in software development teams.** Vision and task orientation are moderately related to team productivity in software development teams. **Participative safety is not related to team productivity.** Support for innovation is weakly related to team productivity. In other words, to achieve team productivity one should have strong vision in the team. Even if there is enough support for innovation and task orientation also, without vision the team can not be productive.

2. **Relationship between team climate and team performance in Software development teams**

Based on Table 6.1, **team climate is related to team performance in software development teams. Vision is strongly related to team performance.** Support for innovation and participative safety are moderately related to team performance. The findings also indicate that task orientation is not related to team performance. Even if there is enough of task orientation in the team, without vision, support for innovation and participative safety one can not get a better team performance in software development teams.

3. **Relationship between team climate and team innovation in Software development teams**

Based on Table 6.1, in software development teams, **team climate is related to team innovation.** This is in line with research done by Anderson and West (1998) on team climate and team innovation. To make a team innovative, team climate is a one soft factor to be concentrated; this was proved in many innovation studies such as Wei and Xie (2008) and MacCurtain, Flood, Ramamoorthy, West and Dawson (2008).

The current research findings indicate that support for innovation is strongly related to team innovation and participative safety is moderately related to team innovation in software development teams. Vision and task orientation are not related to team innovation at all according to this current study of software development teams.

In Yuan, Chaoying, and Peng (2008) study on R & D teams in China also team climate was positively related to team innovativeness. They found moderate relationship between vision and perceived innovativeness, strong relationship between task orientation and perceived innovativeness, strong relationship between support for innovation and perceived innovativeness, and weakest relationship between participative safety and innovativeness.

4. **Relationship between team productivity and team performance in Software development teams**

Team productivity is strongly related to team performance in software development teams.

5. **Relationship between team innovation and team productivity in Software development teams**

Team innovation is strongly related to team productivity in software development teams.

6. **Relationship between team innovation and team performance in Software development teams**

Team innovation is moderately related to team performance in software development teams.

The findings are also agreeing partially with the findings of Bain, Mann and Pirola-Merlo (2001) that team climate is strongly related to team innovation and team performance in research teams than development teams. Here in the current study also team climate (support for innovation) is strongly related to team innovation in development teams. Bain, Mann and Pirola-Merlo (2001) have done research on team climate and team performance in R & D teams.

In another study on Patterson, Warr and West (2004) identified that climate is strongly related to productivity, but current study indicates moderate relationship between team climate and team productivity. According to the studies Blackburn, Lapré and Van Wassenhove (2002), Little (2004), Chiang and Mookerjee (2004), Jiang and Comstock (2007), maximum team size decreases the team productivity. This is true in this current study as well because there is -20% variation in productivity of the team having maximum team size (T10) over the most productive team (T3).

Hence in summary there is relationship between team climate and team productivity, team climate and team performance, team climate and team innovation and the relationships between team productivity and team performance, team innovation and team productivity are strong and there is moderate relationship between team innovation and team performance in software development teams.

The summary of impact of constructs of team climate such as *vision, task orientation, support for innovation* and *participative safety* on team productivity, team performance and team innovation are as shown in Table 6.2.

Table 0.2: Team Climate Impact on Team Productivity, Team Performance and Team Innovation

Team Climate Construct	**Team Productivity**	**Team Performance**	**Team Innovation**
Vision	No Impact	**YES**	**YES**
Task Orientation	No Impact	No Impact	No Impact
Support for Innovation	No Impact	**YES**	**YES**
Participative Safety	No Impact	No Impact	**YES**

(Source: Researcher)

The above table indicates that **vision has impact on team performance and team innovation, support for innovation has impact on team performance and team innovation, participative safety has impact on team innovation** in software development teams. Also it interprets that the vision is not having any impact on team productivity, task orientation is not having impact on any of team productivity, team performance or team innovation. Support for innovation is not having impact on team productivity. Participative safety is not having impact on team productivity and team performance in software development teams.

In other words, **no construct of team climate has impact individually on team productivity** in software development teams. Vision and support for innovation have impact on team performance. Vision, support for innovation and participative safety have impact on team innovation. Among team climate constructs, **task orientation is not having impact on any of team productivity, team performance or team innovation.**

More number of team climate constructs are impacting the team innovation, next team performance and not at all impacting the team productivity in software development teams.

Overall Team climate as a single variable has impact on the other dependent variables. Overall Impact table for the variables team climate, team productivity, team performance and team innovation are as shown in Table 6.3.

Table 0.3: Summary of Overall Impact

Impact	Team Productivity	Team Performance	Team Innovation
Team Climate	YES	YES	YES
Team Productivity	-	YES	-
Team Performance	-	-	-
Team Innovation	YES	YES	-

(Source: Researcher)

According to the research of Anderson and West (1998) done on hospital management teams, the higher levels of task orientation may correlate with overall team productivity. This is true up to some extent in the current study. That is task orientation is moderately correlated to team productivity and is not having any impact on overall team productivity.

The different impact values such as overall team climate impact on team productivity, team climate impact on team performance, and team climate impact on team innovation indicate that **team climate has major impact on team innovation and moderate impact on team productivity and team performance** in software development teams. This importance of impact of team climate on team innovation is also highlighted in Anderson and West (1998). In the research done by Bain, Mann and Pirola-Merlo (2001) on research and development teams, they observed the strong association between team climate and team performance; team climate and team innovation. This is partially true in the current study that team climate is strongly correlated and has major impact on team innovation. In the current study, team climate is almost having equal impact on both team productivity and team performance.

Team productivity has impact on team performance in software development teams. Team innovation has more impact on team productivity than on team performance in software development teams.

6.2 Contributions of this Research Work

This research work is a major contribution useful to the Indian software industry. One came to know that team climate; performance, productivity and innovation are interlinked and are dependent on constructs such as vision, task orientation, support for innovation and participative safety. If an organization knows these relationships, they can work on the respective areas for better performance, productivity and innovation in their teams. Many Indian software organizations are currently looking at different ways to improve their teams' productivity and performance.

Innovation is one area, where the organization should support for innovation formally, unless this happens, innovation can not be achieved in the team and in its deliverables. This is evident from this current research study.

This is going to be the second research second study in India which has used team climate (TCI) in software development teams. Only one team (Ganesh and Gupta,

2006) from IIT, Bombay has done a study using Team climate inventory. However they have taken Team climate as a dependent variable in their study.

I have come across one more study from Spain (Acuña, Gómez and Juristo, 2008), which used Team Climate Inventory in their study to find out relationship between team climate and quality of the software product.

My study is going to be one among the very few studies which has used Team climate in software development teams. Other researchers used team climate in different teams such as healthcare, R & D, and telecommunications teams but not in software teams. The major contributions of this research work is knowing the differences of team climate, team productivity, team performance, team innovation along demographic variables such as age, gender, education, experience and organizational variables such as team role and team size. Also finding the relationships and impact among of team climate, team productivity, team performance, and team innovation together in software development teams, which no researcher has done till now. Another contribution is recommending the software development team size suitable for Indian context for better productivity and performance.

6.3 Recommendations to Indian Software Industry

In the current study, it is observed that the for team size less than 10 members and team size greater than 15 members the team productivity is much less than the teams having 10 to 15 team members. Hence, it is recommended that for Indian software industry, the ideal team size would be between 10 to 15 members to get better productivity irrespective of the age, gender, education qualifications and experience.

Similarly 10 to 15 is the ideal team size to achieve the team innovation as well. In the current study, it is observed that the teams having 10 to 15 members are more innovative than the teams having different team sizes.

It is recommended that organizations have to concentrate on objectives, team vision and support innovation to achieve better software development team performance. To make a software development team innovative, they have to concentrate on team vision, support for innovation and provide safety for participation. To achieve better software development team productivity, they need to concentrate on team vision and task orientation in the teams. Overall different constructs of team climate are related and impacting the team productivity, team performance and team innovation in software development teams.

6.4 Limitations of the Study

One important thing is there are no standard software estimation practices across industry. If this area is more matured, clear and standard practices are available across software industry about software estimations, more accurate results may come for productivity related questions. This area is still maturing or developing in India.

One more thing is team climate has impact of cultural issues. In this present study cultural issues were not considered because the study is done in one country and in one city. Some of the organizations have restrictions on Internet access, which hampered the response rate of current online survey.

6.5 Directions for Further Research

Further research can be done on what are the other soft factors affecting the performance of software development teams other than team climate. There are so many cultural, language, technical, non-technical, environmental, hardware and software factors which are affecting the performance and productivity of software development teams.

Further research can be concentrated on the soft factors other than team climate which are affecting the performance and productivity of software development teams. Also what are the factors affecting the team climate in software development teams can also be also be researched. What is the impact of diversity, language, culture, top management commitment, employee satisfaction, team leader behavior, team member behavior on team productivity and team performance can be researched further.

What is impact of a team climate on entire organizational performance can also be researched further. Is there any impact of team climate on employee satisfaction, turnaround, attrition, career moves, progression and involvement in work can further be researched.

6.6 Conclusion

Finally the current research findings indicate that team climate is related to team productivity, team performance and team innovation in software development teams. Also in software development teams, team productivity is strongly related to the team performance; team innovation is strongly related to team productivity; team innovation is moderately related to team performance. Team productivity and innovation have significant difference along team size. Team climate has significant differences along team role. Task orientation, support for innovation and participative safety have significant difference along team size. Team performance is not having any significant difference along considered demographic or organizational variables. However, it has impact of team climate and team productivity. With this research, we can come to conclusion that to achieve better software development team productivity, performance and innovation, organizations should concentrate on team climate and it should not be ignored. One can achieve better team and organizational results with better *team climate*.

Bibliography

Abdel-Hamid, T. K. and Madnick, S.E. (1989), "Lessons Learned from Modeling the Dynamics of Software Development", *Communications of the ACM,* Volume 32, Number 12, December 1989, pp. 1426-1438.

Abu Rub, F.A. and Issa, A.A. (2008), "Effects of Workspace on Engineering Software Projects", *Proceedings of the World Congress on engineering 2008*, Vol I, WCE 2008, July 2 – 4, 2008, London, UK

Acuña, S.T., Gómez, M., and Juristo, N. (2008), "Towards understanding the relationship between team climate and software quality – a quasi experimental study", *Empirical Software Engineering*, Vol. 13, Number 4, August 2008, pp. 401-434.

Agrell, A. and Gustafson, R. (1994), "The Team Climate Inventory (TCI) and group innovation: a psychometric test on a Swedish sample of work groups", *Journal of Occupational and Organizational Psychology*, Vol. 67, pp 143-151

Ancona, D.G. and Caldwell, D.F. (1992), "Demography and Design: Predictors of New Product Team Performance", *Organization Science,* Vol. 3, No. 3, August 1992, pp. 321-341.

Anderson, N., De Dreu, C.K.W., and Nijstad, B.A. (2004), "The routinization of innovation research: a constructively critical review of the state-of-the-science", *Journal of Organizational Behavior,* Vol 25, pp. 147-173.

Anderson, N.R. and West, M.A. (1994), *The Team Climate Inventory: Manual and User's Guide*, ASE, NFER-Nelson, Windsor, UK

Anderson, N.R. and West, M. A. (1998), "Measuring climate for work group innovation: development and validation of the team climate inventory", *Journal of Organizational Behavior*, Volume 19, Issue 3, May 1998, pp. 235-258.

Andres, H.P. (2002), "A comparison of face-to-face and virtual software development teams", *Team Performance Management: An International Journal,* Vol. 8, Number 1/2, 2002, pp. 39-48.

Arora, A. (2006), "The Indian Software Industry and its Prospects", *Working Paper Series*, The Heinz School of Public Policy and Management, Carnegie Mellon University, USA

Arora, A., Arunachalam, V.S., Asundi, J.M., Fernandes, R.J. (2000), "The Globalization of Software: The Case of The Indian Software Industry", *A Project Report of* The Heinz School of Public Policy and Management, Carnegie Mellon University, USA, February 2000

Athreye, S.S. (2005), "The Indian Software industry and its evolving service capability", *Industrial and Corporate Change,* Oxford University Press, Vol. 14(3), 2005, pp. 393-418.

Athreye, S.S. (2010), "Economic Adversity and Entrepreneurship-led Growth: Lessons from the Indian Software Sector", Working Paper No. 2010/04, United Nations University, World Institute for Development Economics Research, UNU-WIDER

Atkinson, M. (2004), "Measuring the Performance of the IT Function in the UK Health Service using a Balanced Scorecard Approach", *Electronic Journal of Information Systems Evaluation,* Volume 7, Issue 1, pp. 1-10.

Bahli, B. and Büyükkurt, M.D. (2005), "Group Performance in Information Systems Project Groups: An Empirical Study", *Journal of Information Technology Education,* Volume 4, 2005, pp. 97-113.

Bain, P.G., Mann, L. and Pirola-Merlo, A. (2001), "The innovation imperative: The Relationships Between Team Climate, Innovation, and Performance in Research and Development Teams ", *Small Group Research*, Vol. 32, No. 1, pp. 55-73.

Bajpai, N. and Shastri, V. (1998), "Software Industry in India: A Case Study", Development Discussion Paper Number: 667, *Harvard Institute for International Development,* December 1998

Banker, R.D. and Kauffman, R. J. (1991), "Reuse and Productivity in Integrated Computer-Aided Software Engineering: An Empirical Study", *MIS Quarterly,* September 1991, Volume 14, No. 3, pp. 374-401.

Banker, R.D., Datar, S.M. and Kemerer, C.F. (1987), "Factors Affecting Software Maintenance Productivity: An Exploratory Study", Proceedings of the *International Conference on Information Systems,* December 1987

Banker, R.D., Datar, S.M. and Kemerer, C.F. (1991), "A Model to Evaluate Variables Impacting the Productivity of Software Maintenance Projects", *Management Science,* Vol. 37, No. 1, January 1991, pp. 1-18.

Basaglia, S., Caporarello, L. and Magni, M. (2009), "The mediating role of IT knowledge integration capability in the relationship between team performance and team climate", In Proceedings of *17th European Conference on Information Systems,* Verona, Italy, June 8-10, 2009, Paper 121, pp. 1-13.

Beckman, S.L. and Barry, M. (2007), "Innovation as a Learning Process: Embedding Design Thinking", *California Management Review*, Vol. 50, No. 1, Fall 2007, pp. 25-56.

Biswas, G., Chopra, K.L., Jha, C.S. and Singh, D.V. (2010), *Profile of Engineering Education in India: Status, Concerns and Recommendations,* Narosa Publishing House, New Delhi

Blackburn, J.D., Lapré, M.A. and Van Wassenhove, L.N. (2002), "Brooks' Law Revisited: Improving Software Productivity by Managing Complexity", Vanderbilt University Working paper 2002-85

Boehm, B. (1981), *Software Engineering Economics*, Prentice Hall, Englewood Cliffs, New Jersey, 1981

Bolstad, C.A. and Endsley, M.R. (2000), "Shared Displays and Team Performance", Presented at *Human Performance, Situation Awareness and Automation Conference,* Savannah, GA, October 2000

Bosch, M., Dijkstra, R., Wensing, M., Weijden, T.v.d., and Grol, R. (2008), "Organizational Culture, team climate and diabetes care in small office-based practices", *BMC Health Services Research,* 2008, Vol. 8, No. 180, pp. 1-8.

Bouchaib, B. and. Charboneau, R. (2005), "An Evaluation of Productivity Measurements of Outsourced Software Development Projects: An Empirical Study", Proceedings of the *2nd Software Measurement European Forum*, SMEF 2005, March 16-18, 2005, Rome, Italy

Burca, S., Flood, P., Armstrong, C., McCurtain, S., and Saunders, J. (2007), "Community Mental Health Teams: Determinants of Effectiveness", *Working Paper WP2007-01*, Department of Sociology, University of Limerick, Ireland

Card, D. N. (2006), "The Challenge of Productivity Measurement", Proceeding of *Pacific Northwest Software Quality Conference*, Portland, OR, 2006

Chakraborty, C. and Dutta, D.(2003), "Indian Software Industry: growth patterns, constraints and government initiatives", in *Indian Economic Reforms*, edited by Raghbendra Jha, Palgrave Macmillan, pp. 317-333.

Chatzoglou, P.D. and Macaulay, L.A. (1997), "The Importance of human factors in planning the requirements capture stage of a project", *International Journal of Project Management*, Vol 15, No. 1, pp. 39-53.

Chiang, R. and Mookerjee, V.S. (2004), "Improving Software Team Productivity", *Communications of The ACM*, May 2004, Vol. 47, No. 5, 2004, pp. 89-93.

Chong, E. (2007), "Role balance and team development: A study of team role characteristics underlying high and low performing teams", *Journal of Behavioral and Applied Management,* Vol. 8, No. 3, May 2007, pp. 202-217.

Chudoba, K.M., Lu, M., Watson-Manheim, M.B. and Wynn, E. (2003), "How Virtual are we? Measuring Virtuality and Understanding Its Impact in a Global Organization", *Proceeding of the International Conference on Information Systems,* December 2003

Cockburn, A. (2003), *People and Methodologies in Software Development*, PhD Thesis, Faculty of Mathematics and Natural Sciences, University of Oslo, Norway, 2003

Cohen, S.G. and Bailey, D.E. (1997), "What makes Teams Work: Group Effectiveness Research from the Shop Floor to the Executive Suite", *Journal of Management,* Vol. 23, No. 3, pp. 239-290.

Comstock, C., Jiang, Z. and Naude, P. (2007), "Strategic Software Development: Productivity Comparisons of General Development Programs", *World Academy of Science, Engineering and Technology*, Volume 34, 2007, pp. 25-30.

Curral, L.A., Forrester, R.H., Dawson, J.F., and West, M.A. (2001), "It's what you do and the way that you do it: Team task, team size, and innovation-related group processes", *European Journal of Work and Organizational Psychology,* Vol. 10, Issue 2, pp. 187-204.

Dataquest (2009), "DQ Top 20 Overview: Mixed Signal", *DATAQUEST,* Vol. XXVII, No. 13, July 15, 2009, pp. 36-72.

De Dreu, C.K.W. and West, M.A. (2001), "Minority Dissent and Team Innovation: The importance of participation in decision making", *Journal of Applied Psychology*, Vol. 86, No. 6, pp. 1191-1201.

DeShon, R.P., Kozlowski, S.W.J., Schmidt, A.M., Milner, K.R. and Wiechmann, D. (2004), "A Multiple-Goal, Multilevel Model of Feedback Effects on the Regulation of Individual and Team Performance", *Journal of Applied Psychology,* Vol. 89, No. 6, pp. 1035-1056.

Driskell, J.E. and Salas E. (2005), "Groupware, Group Dynamics and Team Performance", in Bowers, C., Salas, E. and Jentsch, F. (editors), *Creating High-Tech Teams,* American Psychological Association (APA) Books, Washington DC, pp. 11-34.

Dossani, R. (2005), "Origins and Growth of the Software Industry in India", *Working Paper,* Shorenstein APARC, September 2005

Drach-Zahavy, A. and Somech, A. (2001), "Understanding Team Innovation: The Role of Team Processes and Structures", *Group Dynamics: Theory, Research, and Practice,* Vol. 5, No. 2, 2001, pp. 111-123.

Ebrahim, N.A., Ahmed, S. and Taha, Z. (2009), "Innovation and R & D Activities in Virtual Team", *European Journal of Scientific Research*, Vol. 34, No. 3, 2009, pp. 297-307.

Edmondson, A.C., Dillon, J.R. and Roloff, K.S. (2007), "Three perspectives on team learning: Outcome improvement, task mastery and group process", *The Academy of Management Annals*, Volume 1, pp. 269-314.

Ehrlich, K. and Chang, K. (2006), "Leveraging expertise in Global Software Teams: Going Outside Boundaries", Proceedings of the *IEEE International Conference on Global Software Engineering*, October 16-19, 2006, pp. 149-158.

Eisenbeiss, S.A., Knippenberg, D.v and Boerner, S. (2008), "Transformational Leadership and Team Innovation: Integrating Team Climate Principles", *Journal of Applied Psychology,* Vol. 93, No. 6, pp. 1438-1446.

Espinosa, J.A., Kraut, R.E., Lerch, J.F., Slaughter, S.A., Herbsleb, J.D. and Mockus, A. (2001), "Shared Mental Models and coordination in Large-scale, distributed software development", *Twenty Second International Conference on Information Systems (ICIS 2001)*, New Orleans, USA, December 2001

Fredrick, P.B. (1995), *The Mythical Man Month: Essays on Software Engineering*, Second Edition, Addison-Wesley, July 1995

Freedy, A., McDonough, J., Jacobs, R., Freedy, E., Thayer, S., Weltman, G., Kalphat, M. and Palmer, D. (2004), "A Mixed Initiative Human-Robots Team Performance Assessment System for Use in Operational and Training Environments", Presented at *Performance Metrics for Intelligent Systems Workshop 2004* (PerMIS 2004), August 24-26, 2004, Gaithersburg, MD

Galia, F. and Legros, D. (2002), "Complementarities between obstacles to innovation: Empirical Study on a Fresh data set", Paper Presented at *DRUID Summer Conference 2002* on "Industrial Dynamics of the New and Old Economy – Who is embracing whom?", Copenhagen/Elsinore, 6-8 June 2002

Garson, G.D. (2007), "Structured Equation Modeling", Available online at http://www2.chass.ncsu.edu

Garver, M.S. and Mentzer, J.T. (1999), "Logistics research methods: Employing structural equation modeling to test for construct validity", *Journal of Business Logistics,* Vol. 20, No. 1, pp. 33-57.

Ganesh, M. P. and Gupta, M. (2006), "Study of virtualness, task interdependence, extra-role performance and team climate in Indian software development teams", Proceedings of the 20th *Australian New Zealand Academy of Management (ANZAM) Conference on "Management: Pragmatism, Philosophy, Priorities"*, 6-9 December 2006, Central Queensland University, Rockhampton

Gautam, T., Upadhyay, N., Dick, R.V., and Wagner, U. (Undated), "Team Climate and its linkage to Organizational Commitment in Nepal", Article available at *Social Sciences Research Foundation*, Nepal

Gilson, R.L., and May, D.R. (2005), "Innovation in Work Groups: a Theory of Group Support for Innovation", Proceeding of *2005 Midwest Academy of Management Conference*, March 31 – April 2, 2005, Chicago, IL

Gliem, J.A. and Gliem, R.R. (2003), "Calculating, Interpreting, and reporting Cronbach Alpha reliability coefficient for Likert-type scale", In *Proceedings of Midwest Research to Practice conference in Adult, Continuing, and Community Education*, 2003.

Goh, T.T. and Eccles, M.P. (2009), "Team Climate and quality of care in primary health care: a review of studies using the team climate inventory in the United Kingdom", *BMC Research Notes,* 2:222, 29 October 2009, pp. 1-5.

GoI (2010), *Information Technology: Annual Report 2009-10,* Department of Information Technology, Ministry of Communications & Information Technology, Government of India

GoI (Undated), "Information Technology and Information Technology Enabled Services (ITES)", ITP Division, Ministry of External Affairs, Government of India, Available online at http://www.indiainbusiness.nic.in/industry-infrastructure/service-sectors/it.htm,

Gondal, A.M. and Khan, A. (2008), "Impact of Team Empowerment on Team Performance Case of The Telecommunications Industry in Islamabad", *International Review of Business Research Papers,* Vol. 4, No.5, October-November 2008, pp. 138-146.

Gupta, A., Mishra, P., and Chakraborty, P. (2007), "Overall Trends in IT Spending in India by Industry Verticals: 2006-2010", IDC, Gurgaon, India

Hann, M., Bower, P., Campbell, S., Marshall, M. and Reeves, D. (2007), "The association between culture, climate and quality of care in primary health care teams", *Family Practice – an international journal,* Oxford University Press, 2007, pp. 323-329.

Hastie, S. (2004), "The Agile Mindset: what does it take to make this stuff work?", Presented at *Agile Development Conference*, Wellington & Sydney, September 2004

Horii, T., Jin, Y. and Levitt, R.E. (2005), "Modeling and Analyzing Cultural Influences on Project Team Performance", *Computational & Mathematical Organization Theory,* Volume 10, Number 4, January 2005, pp. 305-321.

Huang, J. and Wang, S. (2002), "Knowledge conversion abilities and knowledge creation and innovation: A new perspective on Team Composition", *Proceedings of* *the Third European Conference on Organizational Knowledge, Learning and Capabilities*, Athens, Greece, 5-6 April 2002.

Huber, R.K., Eggenhofer, P.M., Römer, J., Schäfer, S. and Titze, K. (2007), "Effects of Individual and Team characteristics on the performance of small networked teams", *The International C2 Journal,* Vol. 1, No.1, pp. 113-144.

Huckman, R.S., Staats, B.R. and Upton, D.M. (2009), "Team Familiarity, Role Experience, and Performance: Evidence from Indian Software Services", *Management Science,* Vol. 55, No. 1, January 2009, pp. 85-100.

Illiyan, A. (2008), "Performance, Challenges and Opportunities of Indian Software Export", *Journal of Theoretical and Applied Information Technology*, Vol. 4, No. 11, pp. 1088-1106.

James, L.R. and Sells, S.B. (1981), "Psychological Climate: Theoretical Perspectives and Empirical Research", in Magnusson, D. (editor), *Towards a Psychology of Situations: An International Perspective*, Erlbaum, Hillsdale, NJ, pp. 275-295.

Jaruzelski, B. and Dehoff, K. (2007), "The Customer Connection: The Global Innovation 1000", *Strategy + Business*, Issue 49, Winter 2007, pp. 1-16.

Jenner, S., Zhao, M. and Foote, T.H. (2010), "Teamwork and Team Performance in online simulations: The Business Strategy Game", *MERLOT Journal of Online Learning and Teaching,* Vol. 6, No. 2, June 2010, pp. 416-430.

Jiang, Z. and Comstock, C. (2007), "The Factors Significant to Software Development Productivity", *World Academy of Science, Engineering and Technology*, Volume 25, January 2007, pp. 160-164.

Jiang, Z., Naude, P. and Comstock, C. (2007), "The Variation of Software Development Productivity 1995-2005", *World Academy of Science, Engineering and Technology*, Volume 27, 2007, pp. 355-359.

Jones, C. (1997), *Applied Software Measurement: Assuring Productivity and Quality*, 2nd Edition, McGraw-Hill, NY

Jones, C. (2006), "Positive and Negative Innovations in Software Engineering", Version 3, Whitepaper of *Software Productivity Research LLC*, December 24, 2006

Katzenbach, J.R. and Smith, D.K. (1993), *The Wisdom of Teams*, Harvard Business School Press, Boston, MA, 1993

Katzenbach, J.R. and Smith, D.K. (2005), *The Wisdom of Teams: Creating the High Performance Organization,* Collins Business Essentials, An Imprint of HarperCollins Publishers, NY

Katzenbach, J.R. and Smith, D.K. (2005a), "The Discipline of Teams", *Harvard Business Review*, July-August 2005, pp. 162-171.

Kirkman, B.L., Rosen, B., Tesluk, P.E. and Gibson, C.B. (2004), "The Impact of team empowerment on virtual team performance: The moderating role of face-to-face interaction", *Academy of Management Journal,* Vol. 47, No. 2, April 2004, pp. 1-18.

Kivimäki, M., Vanhala, A., Pentti, J., Länsisalmi, H., Virtanen, M., Elovainio, M., and Vahtera, J. (2007), "Team Climate, intention to leave and turnover among hospital employees: Prospective cohort study", *BMC Health Services Research* 2007, Vol. 7, Issue 170, pp. 1-8.

Kline, R.B. (1998), *Principles and Practice of Structured Equation Modeling,* The Guilford Press, New York, USA

Krishnan, M.S., Kriebel, C.H., Kekre, S. and Mukhopadhyay, T. (2000), "An Empirical Analysis of Productivity and Quality in Software Products", *Management Science,* Volume 46, Issue 6, June 2000, pp 745-759.

Krishnan, R.T. and Prabhu, G.N. (1999), "Creating Successful New Products: Challenges for Indian Industry", *Economics & Political Weekly,* 31 July 1999, pp. M114-M120.

Kumar, R.R. (2011), "Team Climate and Work environment of Banking sector in Ethiopia – An Observational study", *Journal of Banking Financial Services & Insurance Research,* Vol. 1, No. 9, pp. 1-27.

Leifer, L., Culpepper, J., Ju, W., Cannon, D. and Eris, O. (2002), "Measuring the Performance of Online Distributed Team Innovation (learning) Services", *eTEE 02 DTISadoption Metrics*, 11 July 2002, pp. 1-23.

Liang, T, Liu, C., Lin, T. and Lin, B. (2007), "Effect of Team diversity on Software Project Performance", *Industrial Management & Data Systems,* Vol. 107, No. 5, pp. 636-653.

Lin, H. (2007), "Knowledge Sharing and Firm Innovation Capability: an empirical study", *International Journal of Manpower,* Vol. 28, No. 3/4, 2007, pp. 315-332.

List, B., Bruckner, R. and Kapaun, J. (2005), "Holistic Software Process Performance Measurement: From Stakeholders' Perspective", Proceedings of the *Sixteenth International Workshop on Database and Expert Systems Applications,* IEEE Press, 2005, pp. 941-947.

Little, T. (2004), "Value Creation and Capture: A model of the Software Development Process", *IEEE Software*, May/June 2004, pp. 48-53.

Liu, F. and Cheng, K. (1996), "Investigating the relationship between Knowledge Sharing and Team Innovation Climate", Paper of *Office of Research and Development*, Chang Gung University, Taiwan

Loch, C., Stein, L. and Terwiesch, C. (1996), "Measuring Development Performance in the Electronics Industry", *Journal of Product Innovation Management*, 1996, 13, pp. 3-20.

Lopez, M. (2007), "Estimation of Cronbach's alpha for sparse datasets", In Proceedings of *20th Annual Conference of the National Advisory Committee on Computing Qualifications (NACCQ), 2007*, Nelson, New Zealand, pp. 151-155.

Mathieu, J.E., Heffner, T.S., Goodwin, G.F., Salas, E. and Cannon-Bowers, J.A. (2000), "The Influence of Shared Mental Models on Team Process and Performance", *Journal of Applied Psychology*, Vol. 85, No. 2, pp 273-283.

Mathisen, G.E, Einarsen, S., Jørstad, K. and Brønnick, K.S. (2004), "Climate for work group creativity and innovation: Norwegian validation of the team climate inventory (TCI)", *Scandinavian Journal of Psychology,* Vol. 45, No. 5, pp. 383-392.

MacCurtain, S., Flood, P.C., Ramamoorthy, N., West, M.A., and Dawson, J.F. (2008), "Top Team Trust, Knowledge Sharing and Innovation", *LINK Working Paper Series*, WP 05-08, DCU Business School, Dublin City University, Ireland

Malanowski, S. (2007), "Innovation Incentives: How Companies Foster Innovation", A Paper of *Wilson Group*, September 2007

Malhotra, N.K. (2007), *Marketing Research: An Applied Orientation*, Fifth Edition, Pearson Education, Inc.

Maxwell, K. D. (2001), "Collecting Data for Comparability: Benchmarking software Development Productivity", *IEEE Software*, September/October 2001, pp. 22-25.

Maxwell, K. D. and Forselius, P. (2000), "Benchmarking Software Development Productivity", *IEEE Software*, January/February 2000, pp. 80-88.

McAdam, R., Reid, R.S., Gibson, D.A. (2004), "Innovation and Organizational Size in Irish SMEs: An empirical study", *International Journal of Innovation Management*, Vol. 8, No. 2, pp. 147-165.

McDowell, W.C., and Zhang, L. (2009), "Mediating effects of Potency on Team cohesiveness and team innovation", *Journal of Organizational Leadership & Business,* Summer 2009, pp. 1-11.

NASSCOM (2009), "NASSCOM Strategic Review 2009: Executive Summary", *National Association of Software Service Companies (NASSCOM)*, India

NASSCOM (2009a), "Indian IT-BPO Industry 2009: NASSCOM Analysis", *National Association of Software Service Companies (NASSCOM)*, India

NASSCOM (2010), "NASSCOM Strategic Review 2010: Executive Summary", *National Association of Software Service Companies (NASSCOM)*, India

Na, K., Simpson, J.T., Li, X., Singh, T. and Kim, K. (2007), "Software development risk and project performance measurement: Evidence in Korea", *The Journal of Systems and Software 80 (2007),* pp. 596-605.

Narayana Murthy (2000), "The Software Industry in India: Opportunities and Challenges", *Analytical Report*, United Nations Public Administration Network (UNPAN), 2000

Nogueira, J. C., Luqi, Berzins, V. and Nada, N. (2000), "A Formal Risk Assessment Model for Software Evolution", Paper Presented at *Second International Workshop on Economics-Driven Software Engineering (EDSER-2)*, June 6, 2000, Limerick, Ireland

Nwelih, E. and Amadin, I.F. (2008), "Modeling Software Reuse in Traditional Productivity Model", *Asian Journal of Information Technology*, 7 (11), pp 484-488, 2008.

Ong, A., Tan, G.W. and Kankanhalli, A. (2005), "Team Expertise and Performance in Information Systems Development Projects", *The Ninth Pacific Asia Conference on Information Systems,* July 7-10, 2005, Bangkok, Thailand

Panuwatwanich, K., Stewart, R., and Mohamed, S. (2008), "The role of Climate for Innovation in enhancing business performance: the case of design firms", *Engineering, Construction and Architectural Management,* Vol. 15, No. 5, pp. 407-422.

Parasuraman, A., Berry, L.L. and Zeithaml, V.A. (1991), "Refinement and reassessment of the SERVQUAL scale", *Journal of Retailing*, Vol. 67, No. 4, pp. 420-450.

Partington, D. and Harris, H. (1999), "Team role balance and team performance: an empirical study", *The Journal of Management Development,* Vol. 18, No. 8, pp. 694-705.

Patterson, M., Warr, P., and West, M. (2004), "Organizational Climate and Company Productivity: The role of Employee Affect and Employee Level", CEP Discussion Paper No 626, Centre for Economic Performance, London School of Economic and Political Science, London

Pattit, J.M. and Wilemon, D. (2005), "Creating high-performing software development teams", *R & D Management,* Vol. 35, No. 4, 2005, pp. 375-393.

Pendharkar, P.C. and Rodger, J.A. (2007), "An empirical study of the impact of team size on software development effort", *Information Technology and Management,* Vol. 8, No. 4, pp. 253-262.

Pinkowska, M. (Undated), "IT Software Project Management: Impact of Team Cohesiveness on Productivity and Performance", Available online at http://www.lent.ch/pdf_diverse/Pinkowska-cohesiveness.pdf (Accessed on 02-Mar-2010)

Potok, T. E. and Vouk, M.A. (1999), "A Model of Correlated Team Behavior in a Software Development Environment", Proceedings of *IEEE Symposium on Application-specific Systems and Software Engineering and Technology*, ASSET' 99, 1999, Richardson, TX

Premraj, R., Kitchenham, B., Shepperd, M. and Forselius, P. (2005), "An Empirical Analysis of Software Productivity over Time", *11th IEEE International Symposium on Software Metrics*, Como, Italy, 19-22 September 2005

Pressman, R.S. (2009), *Software Engineering: A Practitioner's Approach,* 7th Edition, McGraw-Hill Higher Education, 2009

Proudfoot, J., Jayasinghe, U.W., Holton, C., Grimm, J., Burner, T., Amoroso, C., Beilby, J., Harris, M.F., and PRACCAP Research Team (2007), "Team Climate for Innovation: What difference does it make in general practice?", *International Journal for Quality in Health Care*, Oxford University Press, March 2, 2007, pp. 1-6.

Radoiu, D., Enachescu, C. and Pop, H.F. (2006), "Improving Virtual Team Performance: An Empirical Approach", A research paper of Sysgenic Sourcing, Available at sourcing.sysgenic.com (Accessed on 10-Mar-2010)

Ramachandran, S., Jensen, R. and Salas, E. (2008), "Developing Team Performance Models: From Abstract to Concrete", *Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC) 2008,* Paper No. 8318

Ramasubbu, N. and Balan, R.K. (2007), "Globally Distributed Software Development Project Performance: An Empirical Analysis", *ESEC-FSE'07,* September 3-7, 2007, Cavtat near Dubrovnik, Croatia

Reichers, A.E. and Schneider, B. (1990), "Climate and Culture: An evolution of constructs", in Schneider, B. (editor), *Organizational Climate and Culture,* Jossey-Bass, San Francisco, USA

Rico, D. F. (Undated), "Virtual Teams and the Factors of Performance", Available online at http://davidfrico.com/rico05j.pdf (Accessed on 05-Apr-2010)

Rodríguez, D., Sicilia, M.A., García, E. and Harrison, R. (2011), "Empirical Findings on Team size and Productivity in software development", Accepted for *Journal of*

Systems and Software, 2011, Available online at http://www.cc.uah.es/drg/publications.html (Accessed on 29-Dec-2011)

Rouse, W.B. (1992), "The Role of Mental Models in Team Performance in Complex Systems", *IEEE Transactions on Systems, Man, and Cybernetics,* Vol. 22, No. 6, November/December 1992, pp. 1296-1308.

Saunders, M., Lewis, P. and Thornhill, A. (2003), *Research Methods for Business Studies,* Pearson Education (Singapore) Pte. Ltd., Singapore.

Sawyer, S. (2001), "Effects of Intra-Group Conflict on Packaged Software Development Team Performance", *Information Systems Journal*, Vol. 11, No. 2, pp. 155-178.

Sawyer, S. and Guinan, P.J. (1998), "Software development: Processes and Performance", *IBM Systems Journal,* Vol. 37, No. 4, 1998, pp. 552-569.

Scacchi, W. (1995), "Understanding Software Productivity", *Advances in Software Engineering and Knowledge Engineering,* Volume 4, 1995, pp. 37-70.

Scott, E. and Pollock, M. (2006), "Effectiveness of self selected teams: A systems development project experience", *Issues in Informing Science and Information Technology,* Vol. 3, pp. 601-617.

Shashwat, D.C. (2009), "Indian Software Products: Still Not There", *DataQuest*, August 13, 2009, pp. 1-2.

Shim, K.J. and Srivastava, J. (2010), "Team Performance Prediction in Massively Multiplier online Role-playing games (MMORPGs)", *Proceedings of the IEEE Social Computing (SocialCom-10),* August 20-22, 2010, Minneapolis, Minnesota, USA.

Sivasubramaniam, N., Murry, W.D. , Avolio, B.J. and Jung, D.I. (2002), "A Longitudinal Model of the Effects of Team Leadership and Group Potency on Group Performance", *Group & Organization Management,* Vol. 27, No. 1, March 2002, pp. 66-96.

Smith, E., Borgvall, J. and Lif, P. (2007), "Team and Collective Performance Measurement", *Report of NATO Research and Technology Organization*, RTO-TR-HFM-121-Part-II

Smith, R.K., Hale, J. and Parrish, A. (2001), "An empirical study using task assignment patterns to improve the accuracy of software effort estimation", *IEEE Transaction on Software Engineering,* Vol. 27, No. 3, March 2001, pp. 264-271.

Sridhar, V., Paul, R., Nath, D. and Kapur, K. (2007), "Analyzing Factors that affect performance of global virtual teams", Second International Conference on *Management of Globally Distributed Work*, Indian Institute of Management, Bangalore, India

Stahl, G.K., Maznevski, M.L., Voigt, A. and Jonsen, K. (2010), "Unraveling the effects of cultural diversity in teams: A meta analysis of research on multicultural work groups", *Journal of International Business Studies,* Vol. 41, pp. 690-709.

Stewart, K.J. and Gosain, S. (2006), "The moderating role of development stage in free/open source software project performance", *Software Process Improvement and Practice,* Vol. 11, pp. 177-191.

Strating, M.MH. and Nieboer, A.P. (2009), "Psychometric test of the Team Climate Inventory-short version investigated in Dutch quality improvement teams", *BMC Health Services Research*, 2009, 9(126), pp. 1-7.

Streitz, N.A., Geiβler, J., Holmer, T., Konomi, S., Müller-Tomfelde, C., Reischl, W., Rexroth, P., Seitz, P. and Steinmetz, R. (1999), "i-LAND: An interactive landscape for Creativity and Innovation", *Proceedings of the ACM Conference on Human Factors in Computing Systems, CHI'99*, Pittsburgh, PA, USA, May 15-20, 1999, ACM Press, New York, pp. 120-127.

Tausworthe, R. C. (1982), "Staffing Implications of Software Productivity Models", TDA Progress Report 42-72, October-December 1982

Teasley, S. , Covi, L., Krishnan, M.S. and Olson, J.S. (2000), "How does Radical Collocation Help a Team Succeed?", Proceedings of the *2000 ACM Conference on Computer Supported Cooperative Work,* Philadelphia, Pennsylvania, USA, pp. 339-346

The Economic Times (2010), "India 2009/10 Software Export growth seen 5.5 pc", The Economic Times, 4th Feb 2010, Available online at http://economictimes.indiatimes.com/infotech/software/India-2009/10-software-export-growth-seen-55-pc/articleshow/5534400.cms

Tockey, S. (1996), "The Effect of Team Size on Team Productivity and Project Cost", *Lecture notes of Software Project Management, CSSE-515*, Winter 2000, Seattle University

Tschang, T. (2001), "The Basic Characteristics of Skills and Organizational Capabilities in the Indian Software Industry", *Working Paper Series No. 13*, Asian Development Bank Institute, Tokyo

Turner, R. and Boehm, B. (2003), "People Factors in Software Management: Lessons From Comparing Agile and Plan-Driven Methods", *The Journal of Defense Software Engineering*, December 2003, pp. 4-8.

Tushman, M., Smith, W.K., Wood, R.C., Westerman, G., O'Reilly, C. (2006), "Organizational Designs and Innovation Streams", *Working Paper 07-087*, Harvard Business School, Boston, MA, September 8, 2006

Vyhmeister, R. (1996), "Programmer Productivity", Available online at http://www.andrews.edu/~vyhmeisr/papers/progprod.html (Accessed on 02-Mar-2010)

Wagner, J.A. (1994), "Participation's effects on Performance and Satisfaction: A reconsideration of research evidence", *Academy of Management Review*, Vol. 19, pp. 312-330.

Wagner, S. and Ruhe, M. (2008), "A Structured Review of Productivity Factors in Software Development", Technical Report, *Technische Universität München*, 2008

Wagner, S. and Ruhe, M. (2008a), "A Systematic Review of Productivity Factors in Software Development", Proceedings of 2nd *International Workshop on Software Productivity Analysis and Cost Estimation (SPACE 2008),* State Key Laboratory of Computer Science, Institute of Software, 2008

Wallace, L., Keil, M. and Arun Rai (2004), "How Software Project Risk affects Project Performance: An Investigation of the Dimensions of Risk and an Exploratory Model", *Decision Sciences,* Volume 35, Number 2, Spring 2004, pp. 289-321.

Walston, C.E. and Felix, C.P. (1977), "A method of Programming measurement and estimation", *IBM Systems Journal*, Vol. 16, No. 1, pp. 54-73.

Wei, X. and Xie, F. (2008), "Knowledge Management Processes and Innovation: an empirical analysis of firms in software cluster", *International Journal of Human Resources Development and Management,* Vol. 8, Nos. 1/2, 2008, pp. 25-42.

Wengel, J., Lay, G., Nylund, A., Bager-Sjögren, L., Stoneman, P., Bellini, N. and Shapira, P. (2000), "Analysis of Empirical surveys on Organizational Innovation and lessons for future community innovation surveys", *Final Project Report of Contract CIS 98/191*, Fraunhofer Institute for Systems and Innovation Research, Germany

West, M.A. (1990), "The Social Psychology of innovation in groups", in West, M.A. and Farr, J.L. (editors), *Innovation and Creativity at Work: Psychological and Organizational Strategies*, Wiley, Chichester, pp. 4-36

West, M.A. and Farr, J.L. (1989), "Innovation at Work: Psychological Perspectives", *Social Behaviour*, Vol. 4, pp. 15-30.

Wettstein, T. and Kueng, P. (2002), *Management Information Systems 2002: Incorporating GIS and Remote Sensing,* edited by C.Brebbia and P.Pascola, WIT Press, Southampton 2002, pp. 113-122.

White, K.S. (1999), "Software Engineering Management for Productivity and Quality", *International Conference on Accelerator and Large Experimental Physics Control Systems*, Trieste, Italy, 1999

Xue, D., Corrêa, M.F.S., Angel, F.A., Molina, S., Holleger, M., and Gosch, R. (2007), "Teams – How to make sure that you never succeed!", *Euroweek Telemark 2007*, 29 April-6 May 2007, pp. 1-37.

Yilmaz, L. (2008), "Innovation Systems are Self-Organizing Complex Adaptive Systems", *Symposia of Association for the Advancement of Artificial Intelligence (AAAI)*, Spring 2008

Yiyong, OU (2008), "How Team Spirit Improve Product Innovation: The Role of Shared Vision and Knowledge Acquisition", *2008 International Conference on Computer Science and Software Engineering*, *CSSE 2008,* IEEE Computer Society, 12-14 December 2008, Wuhan, Hubei, China

Yuan, L., Chaoying, T., Peng, G., (2008), "Chinese Validation of the Team Climate Inventory: A Measure of Team Climate for Innovation in R & D Teams", Proceedings of *5th International Conference on Innovation & Management*, December 10-11, 2008, UNU-MERIT, Maastricht, The Netherlands

Zellmer-Bruhn, M. and Gibson, C. (2006), "Multinational Organization Context: Implications for Team learning and Performance", *Academy of Management Journal,* Vol. 49, No. 3, pp. 501-518.

Appendix – 1: Detailed Questionnaire

Team Climate Inventory (TCI) Questionnaire

This questionnaire should be answered by team member, team leader or project manager working in a software development project. Please mark 1- Strongly disagree, 2-disagree, 3- Neutral, 4-agree and 5 - Strongly agree for Opinion column.

Sl. No.	Question	Opinion
Vision		
1	How clear are you about what your team's objectives are?	
2	To what extent do you think they are useful objectives?	
3	How far are you in agreement with these objectives?	
4	To what extent do you think your team's objectives are clearly understood by other members of the team?	
5	To what extent do you think other team members agree with these objectives?	
6	To what extent do you think your team's objectives actually can be achieved?	
7	How worthwhile do you think these objectives are?	
8	How worthwhile do you think these objectives are to the organisation?	
9	How worthwhile do you think these objectives are to the wider society?	
10	To what extent do you think these objectives are realistic and can be attained?	

11	To what extent do you think members of your team are committed to these objectives?	
Task Orientation		
12	Do your team colleagues provide useful ideas and practical help to enable you to do the job to the best of your ability?	
13	Do you and your colleagues monitor each other so as to maintain a higher standard of work?	
14	Are team members prepared to question the basis of what the team is doing?	
15	Does the team critically appraise potential weaknesses in what it is doing in order to achieve the best possible outcome?	
16	Do members of the team build on each other's ideas in order to achieve the best possible outcome?	
17	Is it a real concern among the team members that the team should achieve the highest standards of performance?	
18	Does the team have clear criteria which members try to meet in order to achieve excellence as a team?	
Support for Innovation		
19	The team is always moving toward the development of new answers	
20	In this team, we take the time needed to develop new ideas	
21	Assistance in developing new ideas is available	
22	The team is open and responsive to change	
23	People in this team cooperate in order to help develop and apply new ideas	
24	People in this team are always searching for fresh, new	

	ways of looking at problems	
25	Members of the team provide and share resources to help in the application of new ideas	
26	Team members provide practical support for new ideas and their application	
Participative Safety		
27	We share information generally in the team rather than keeping it to ourselves	
28	We have a 'we are together' attitude	
29	We all influence each other	
30	People keep each other informed about work-related issues in the team	
31	People feel understood and accepted by each other	
32	Everyone's view is listened to, even if it is in a minority	
33	There are real attempts to share information throughout the team	
34	There is a lot of give and take	
35	We keep in regular contact with each other	
36	We interact frequently	
37	We keep in touch with each other as a team	
38	Members of the team meet frequently to talk both formally and informally	

Team Productivity Questionnaire

Sl. No.	Question	Value
1	How many number of Function Points were implemented in the last project phase/Module by your team	
2*	How many Kilo Lines of Source Code (KLOC) was Written in the last project phase/Module by your team	
3	How many man months of your team's effort was involved in the above Function Points (FPs) or KLOC implementation	

* This item has been removed from Questionnaire after Pilot study

Team Performance Questionnaire

Sl. No.	Question	Opinion
1	Efficiency of project team operations	
2	Quality of system produced by the project team	
3	Adherence to schedules during the project	
4	Amount of work the project team produced	
5	Ability of the project team to meet the goals/commitments of the project	
6	Extent to which the system adds value to our firm.	
7	The extent to which the system adheres to organizational standards	
8	Extent to which the users' business needs are reflected in the system	
9	Number of defects in the system	
10	The contribution of the system to the performance of the firm.	

Team Innovation Questionnaire

Sl. No.	Question	Opinion
1	Team members often implement new ideas to improve the quality of our products and services	
2	The team gives little consideration to new alternative methods and procedures for doing their work	
3	Team members often produce new services, methods, or procedures.	
4	This is an innovative team.	

Demographic and Organizational Details

Please furnish the following details:

1.	Age:	
2.	Gender:	
3.	Education Qualifications:	
4.	Total Experience (in Years):	
5.	Organization Name:	
6.	Business Unit/Department Name:	
7.	Project Name:	
8.	Team Size:	
9.	Role:	Team Member / Team Manager
10.	Tenure of Service in this Organization (in months)	
11.	Tenure in this project team (in months)	

Appendix – 2: Sample LISREL/SIMPLIS Scripts

This appendix gives the detailed SIMPLIS scripts written to draw the path diagrams using LISREL 8.5.

Script (1): SIMPLIS Script for Path diagram of Team Climate relationship with Team Performance, Team Productivity and Team Innovation

The Following script is used to generate the path diagram to show the relationship between team climate, team productivity, team performance, and team innovation.

SYSTEM FILE from file 'C:\Documents and Settings\user\Desktop\Lisrel test\pathdgm1.DSF'

Latent Variables teamclim teamperf teamprod teaminno

Relationships

TC1 = teamclim

TC2 = teamclim

TC3 = teamclim

TC4 = teamclim

TC5 = teamclim

TC6 = teamclim

TC7 = teamclim

TC8 = teamclim

TC9 = teamclim

TC10 = teamclim

TC11 = teamclim

TC12 = teamclim

TC13 = teamclim

TC14 = teamclim

TC15 = teamclim

TC16 = teamclim

TC17 = teamclim

TC18 = teamclim

TC19 = teamclim

TC20 = teamclim

TC21 = teamclim

TC22 = teamclim

TC23 = teamclim

TC24 = teamclim

TC25 = teamclim

TC26 = teamclim

TC27 = teamclim

TC28 = teamclim

TC29 = teamclim

TC30 = teamclim

TC31 = teamclim

TC32 = teamclim

TC33 = teamclim

TC34 = teamclim

TC35 = teamclim

TC36 = teamclim

TC37 = teamclim

TC38 = teamclim

TPR1 = teamperf

TPR2 = teamperf

TPR3 = teamperf

TPR4 = teamperf

TPR5 = teamperf

TPR6 = teamperf

TPR7 = teamperf

TPR8 = teamperf

TPR9 = teamperf

TPR10 = teamperf

TY1 = teamprod

TY2 = teamprod

TY3 = teamprod

TI1 = teaminno

TI2 = teaminno

TI3 = teaminno

TI4 = teaminno

Set the Variance of teamclim to 1.00

Set the Variance of teamperf to 1.00

Set the Variance of teamprod to 1.00

Set the Covariances of teaminno and teamperf to 0.00

Set the Covariances of teaminno and teamprod to 0.00

Set the Variance of teaminno to 1.00

Lisrel Output: AD=OFF

Path Diagram

Method of Estimation: Maximum Likelihood

End of Problem

Another script used to draw path diagrams to show the relationship between different components of team climate such as vision, task orientation, support for innovation and participative safety and team performance, team productivity and team innovation is given below.

SYSTEM FILE from file 'C:\Documents and Settings\user\Desktop\Lisrel test\pathdgm10.DSF'

Latent Variables vision taskorie suppinno partsafe teamperf teamprod teaminno

Relationships

TC1 = vision

TC2 = vision

TC3 = vision

TC4 = vision

TC5 = vision

TC6 = vision

TC7 = vision

TC8 = vision

TC9 = vision

TC10 = vision

TC11 = vision

TC12 = taskorie

TC13 = taskorie

TC14 = taskorie

TC15 = taskorie

TC16 = taskorie

TC17 = taskorie

TC18 = taskorie

TC19 = suppinno

TC20 = suppinno

TC21 = suppinno

TC22 = suppinno

TC23 = suppinno

TC24 = suppinno

TC25 = suppinno

TC26 = suppinno

TC27 = partsafe

TC28 = partsafe

TC29 = partsafe

TC30 = partsafe

TC31 = partsafe

TC32 = partsafe

TC33 = partsafe

TC34 = partsafe

TC35 = partsafe

TC36 = partsafe

TC37 = partsafe

TC38 = partsafe

TPR1 = teamperf

TPR2 = teamperf

TPR3 = teamperf

TPR4 = teamperf

TPR5 = teamperf

TPR6 = teamperf

TPR7 = teamperf

TPR8 = teamperf

TPR9 = teamperf

TPR10 = teamperf

TY1 = teamprod

TY2 = teamprod

TY3 = teamprod

TI1 = teaminno

TI2 = teaminno

TI3 = teaminno

TI4 = teaminno

Set the Variance of vision to 1.00

Set the Variance of taskorie to 1.00

Set the Variance of suppinno to 1.00

Set the Variance of partsafe to 1.00

Set the Variance of teamperf to 1.00

Set the Variance of teamprod to 1.00

Set the Covariances of teaminno and teamperf to 0.00

Set the Covariances of teaminno and teamprod to 0.00

Set the Variance of teaminno to 1.00

Lisrel Output: AD=OFF

Path Diagram

Method of Estimation: Maximum Likelihood

End of Problem

LIST OF PUBLICATIONS BASED ON PRESENT STUDY

By Goparaju Purna Sudhakar

Sl. No:	Title of Paper	Journal Name/ Conference Proceedings	Organization(s)	Issue/Date
1.	**Factors affecting the productivity of Indian Software Development teams in an uncertain economic era**	Proceedings of National Seminar On "Managing in an Uncertain Economic Era – Embracing Change in a Service Economy"	School of Management Studies, University of Hyderabad, Hyderabad, India	November 5 – 7, 2009
2.	**Managing Dynamics in Teams**	Book Chapter in *Organizational Behavior: New Perspectives* edited by G.P.Sudhakar, pp. 88-97. ISBN Number : 978-81-314-2140-6	ICFAI University Press, Hyderabad, India	November 12, 2009
3.	**Multiple book Chapters on Teams**	in the book *Project Management: Training Manual* authored by G.P.Sudhakar, ISBN Number: 978-81-8370-219-8 Chapter Nos: 1, 2, 3, 5, 6, 7, 8 and 16	Akansha Publishing House, New Delhi, India	January 2010
4.	**The Need for High**	*HRM Review,*	IUP	May 2010

	Performance Teams in Indian IT Industry	Vol-X, Issue-V, 2010, pp. 34-36. ISSN Number: 0972-5148	Publications, Hyderabad, India	
5.	**Software Development Team Performance**	*Business Manager,* Vol. 12, No. 12, 2010, pp. 36-37. RNI No. 69888/98	Anil Kaushik at Bharat Printing Press, Alwar, Rajasthan, India	June 2010
6.	**Book Chapters "Project Human Resource Management" and "Project Communications Management" (Team Climate, Team Productivity, Team Performance are discussed)**	In the book *Elements of Software Project Management* , authored by G.P.Sudhakar, ISBN Number: 9788120341616. Team Climate- pp. 119, 184 Team Productivity – pp. 74, 77, 139 Team Performance – pp. 138	Prentice Hall of India (PHI) Learning Ltd, New Delhi, India	August 2010
7.	**Teamwork in Software Organizations**	*CSI Communications,* Vol. 34 Issue. 6, 2010, pp. 22-24. ISSN Number: 0970-647X	Computer Society of India (CSI), Mumbai, India	September 2010
8.	**Understanding Software Development Team Performance**	*Scientific Annals of the "Alexandru Ioan Cuza" University of Iasi: Economic Sciences Series,* Vol.	University of Iasi, Iasi, Romania	November 2010

		57, 2010, pp. 505-513 ISSN Number: 0379-7864		
9.	**Soft Factors affecting the Performance of Software Development Teams**	*Team Performance Management,* Vol. 17, Issue 3/4, 2011, pp. 187-205 ISSN: 1352-7592	Emerald Group Publishing Limited, UK	June 2011
10.	**Measuring Productivity of Software Development Teams**	*Serbian Journal of Management,* Vol. 7, Issue 1, 2012, pp. 01-11. ISSN: 1452-4864	Technical Faculty in Bor, University of Belgrade, Serbia	January 2012
11.	**Empirical research paper**			**To be written after Submitting the Thesis**